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ABSTRACT

This 50-state survey of state policies and initiatives related to mathematics and science education is part of a larger study analyzing the impact of state policies in these states on science instruction in school districts. The purpose of this survey was to identify current state initiatives and policies affecting science and mathematics education in grades K-12 in the 50 states. Information was collected on curriculum guides, graduation requirements, time requirements, special schools or programs, student recognition programs, student assessment, teacher certification and training, funding, serving underrepresented groups and state trends and issues. Survey information was collected from state department of education science and mathematics supervisors or their designee in 50 states, the District of Columbia, and American Samoa. The name, address and telephone number of state contacts appear in the appendices. An overview and highlights of state activities precedes the state-by-state survey information. (CW)

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September 1987

Prepared by
the Education Commission of the States
for
the National Science Foundation

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SURVEY OF STATE INITIATIVES TO IMPROVE SCIENCE AND MATHEMATICS EDUCATION

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1860 Lincoln Street
Denver, Colorado 80295

Prepared by Kim Moyer

September 1987

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The Education Commission of the States is a nonprofit, nationwide interstate compact formed in 1965. The primary purpose of the commission is to help governors, state legislators, state education officials and others develop policies to improve the quality of education at all levels. Forty-eight states, the District of Columbia, American Samoa, Puerto Rico and the Virgin Islands are members. The ECS central offices are at 1860 Lincoln Street, Suite 300, Denver, Colorado 80295. The Washington office is in the Hall of the States, 444 North Capitol Street, Suite 248, Washington, D.C. 20001.

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INTRODUCTION

This 50-state survey of state policies and initiatives related to mathematics and science education was completed by the Education Commission of the States under a grant from the National Science Foundation. This survey is part of a larger study analyzing the impact of state policies in these states on science instruction in school districts.

The purpose of this survey was to identify current state initiatives and policies affecting science and mathematics education in grades K-12 in the fifty states. Information was collected on curriculum guides, graduation requirements, time requirements, special schools or programs, student recognition programs, student assessment, teacher certification and training, funding, serving underrepresented groups and state trends and issues.

Survey information was collected from state department of education science and mathematics supervisors or their designee in 50 states, the District of Columbia and American Samoa. The name, address and telephone number of state contacts appear in Appendix A and Appendix B.

An overview and highlights of state activities precedes the state-by-state survey information.

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HIGHLIGHTS AND OVERVIEW OF STATE SCIENCE AND MATHEMATICS INITIATIVES

States have been very active in the areas of curriculum development; teacher training, recruitment and certification; and student assessment. An overview of state initiatives in these policy areas is presented below; highlights of policies and programs are included to provide information on the range of initiatives.

Curriculum Guides

Curriculum guides for science and mathematics in the 50 states range from very general recommendations to minimum standards that are required for district use. For example, the Mississippi State Curriculum Structure defines and mandates course titles, course descriptions and minimum learning objectives for use in local Instructional Management Programs. Other states have curriculum development guides that may include learner outcomes and are recommended for district use. Connecticut's Common Core of Learning does not define minimum competencies; rather it suggests " . . . an integrated and interdependent set of learner outcomes . . . expected to result from the entire K–12 school experience." A few states, like California, have very comprehensive, recommended guides that integrate curriculum development, textbook adoption and long–term staff– development planning.

Forty–seven states have some form of curriculum guide for science or mathematics; three states, Montana, Nebraska and Wyoming, do not have any form of curriculum guides for any subject area. Twenty–nine of the states have recommended science curriculum guides and 20 have required science guides. Twenty–seven of the states have recommended mathematics curriculum guides and 20 have required mathematics guides. It is important to note that some states have both recommended and required curriculum guides. For example, South Carolina has a recommended Outline of High School Credit Courses and required Basic Skills Objectives for grades K–12. Utah has recommended curriculum guides for grades K–6 and 9–12 and required specific CORE courses for grades 7 and 8.

Higher Order Thinking Skills

Higher order thinking skills top the agenda of many educational policy makers, and most states report activity in this area. Some states incorporate higher order thinking skills through staff development. For example, Iowa and Maine sponsor annual conferences through Title II funds for science and mathematics teachers to promote Problem Solving in Science and Mathematics (PRISMS). In the state of Virginia, inservice workshops have been held on a statewide basis that emphasize higher order thinking skills. Virginia is also developing a series of television programs aired beginning September 1987, that emphasize higher order thinking skills. Other states include these skills in their assessment programs. Missouri

reports that when the Missouri Mastery and Achievement Test (MMAT) items were developed, the writers were instructed to design test items that would assess higher order thinking skills. There has been a review by cognitive psychologists indicating that a " . . . good portion of the MMAT is assessing higher level thinking."

Still other states report that higher order thinking skills underlie and are the basis for their curriculum guides. For example, the Texas Essential Elements for Science, a curriculum framework, is process oriented, and the Essential Elements for Mathematics emphasizes problem solving. The state of Maryland awards curriculum development and implementation grants to districts that emphasize higher order thinking skills. In Minnesota, grants from Cray Research, Inc. and the Minnesota High Technology Council are being used by the Department of Education to define higher order thinking skills and to implement curriculum models that emphasize these skills.

Even though states report general activity in the area of higher order thinking skills, caution must be exercised when analyzing the real effect of that activity. It is questionable whether including such language as "identify," "distinguish" and "demonstrate" in curriculum guides will change the way students think unless concrete activities take place that back up this language. For example, the best way to learn about community affairs is to get involved in them. Providing concrete activities that actually do require students to "identify," "distinguish" and "demonstrate" will automatically develop higher order thinking skills.

Graduation Requirements

In many states, minimum state graduation requirements for science and mathematics have existed for several years; in a few other states, requirements have recently been introduced for the first time. However, many states with long-standing graduation requirements have made changes (mainly increases) during the past few years. According to the survey data, 46 states as well as American Samoa have either introduced or changed state minimum high school graduation requirements for science and/or mathematics since 1974. Only four states, Colorado, Iowa, Massachusetts and Wyoming, do not have state-level graduation requirements. (Colorado has a constitutional prohibition against state high school graduation requirements.)

Some state-level requirements are mandated for use by school districts; others are recommended rather than required for use. Even when state graduation requirements are recommended for use, there is often some pressure for districts to adopt the requirements. For example, Michigan recommends that districts adopt the state-established graduation requirements and offers incentives to districts that do so.
Among the states that have minimum graduation requirements, five require only one science credit for graduation, 36 require two credits and six require three credits. State minimum graduation requirements for mathematics tend to be higher. Only one state requires one mathematics

credit for graduation, 35 of the states require two credits, nine require three credits and only one state requires four credits.

Some states test for basic skills in certain subject areas for high school graduation. While 15 states require an exit–level exam in mathematics, only five states require an exit–level exam in science. Interestingly, every state that requires a science exit exam also requires one for mathematics. The five states that test both science and mathematics knowledge for high school graduation are Florida, Idaho, Illinois, Louisiana and New Mexico. (Note: Louisiana's science exit exam will begin in 1989.)

All of the above requirements apply to standard diplomas; however, several states now offer advanced or honors diplomas that require additional course work or demonstration of competency. For example, requirements for the Indiana Academic Honors diploma include six credits of science and six credits of mathematics. Kentucky students may earn the Commonwealth Diploma by completing three credits of science and four credits of mathematics. In Idaho, a Seal of Proficiency is added to standard diplomas if students pass all four subtests of the Idaho Proficiency Test. In Texas, an advanced notation is placed on transcripts if students complete three years each of science and mathematics and one year of computer science. Missouri's College Preparatory Studies Certificate Program offers incentives to college–bound students or students who simply wish to follow a more rigorous course of study. However, completion of this program does not lead to an advanced diploma but instead to a certificate that signifies outstanding academic achievement. Requirements for this certificate include completion of three units of science and three units of mathematics, a minimum GPA of 3.0 on a 4.0 scale in the combined areas of English/language arts, mathematics, science and social studies as calculated at the end of either the seventh or eighth semester of high school, and scores on the ACT and SAT above the national averages.

Often state graduation requirements are overshadowed by college admission standards. For example, in North Carolina, college–bound students must complete three units of science and three units of mathematics to meet college entrance requirements, which exceed the state minimum graduation requirements of two credits each. In this case, the college entrance requirements have become the de facto high school graduation requirements for college–bound students (beginning with the class of 1988).

Recognition and Awards for Students

Survey respondents were asked to identify state–supported (state– funded) recognition programs for students in science and mathematics. Strictly state–supported programs are rare. The ones that do exist usually follow a common state fair or knowledge–bowl format. For example, the Arkansas Governor's Academy Competition, more commonly known as the Arkansas Quiz Bowl, is a quick recall test of general–knowledge facts in a variety of

subject areas, including science and mathematics. Teams of four from public high schools in the state enter regional competitions; regional winners advance to the state–level competition where prizes include trophies, $1,000 college scholarships and a chance to compete at the national level. Some exemplary state–supported recognition programs were identified and deserve mention.

In 1983, California's Hughes–Hart Educational Reform established the Golden State Examination (GSE) to identify and recognize honors–level achievement by students in specific academic subject areas. Any student enrolled in a subject to be tested may take the GSE. The GSE, first administered in May 1987, covered first–year algebra and geometry. Future tests, planned for the spring of each year, will cover additional mathematics courses, laboratory sciences, U.S. history, English literature and composition, foreign languages and health science. Students are recognized at one of three levels based on statewide standards: high honors, honors and school recognition. Students who achieve high honors or honors receive a certificate acknowledging their outstanding achievement plus an insignia on their high school diploma and a notation on their transcript. Students who achieve school recognition status do not receive certificates from the state but may receive some form of recognition from their schools.

PRIDE, a Program to Recognize Initiative and Distinction in Education, is sponsored by Florida's Commissioner of Education. It identifies outstanding students in the areas of science and mathematics through a series of school, district, regional and state competitions. Top winners receive awards and scholarships to state colleges and universities.

There are multitudes of recognition and award programs at the state level that are privately supported by professional organizations or business and industry, or jointly supported through several resources, including the state. These types of programs often begin at the local or regional level and end at the national level. Programs like those identified below are common to most states.

The Junior Academy of Science, for students in grades 7–12, is sponsored by each state's Academy of Science. Science Olympiads, for grades 8–12, are sponsored by state affiliates of the National Association of Teachers of Science. Junior Science, Engineering and Humanities Symposiums, for grades 9–12, are sponsored by private industry, states and the United States Army.

MathCounts, sponsored mainly by the Society for Professional Engineers, is another popular recognition program in which most states participate. Seventh and 8th grade students form teams and enter regional competitions; the top three teams from each region then enter a state competition. MathCounts culminates in Washington, D.C. with the top team from each state competing for the number–one spot.

Other noteworthy recognition programs include the New York Energy Research and Design Competition, sponsored by the New York State Energy

Research and Development Authority; High Flight, an aerospace workshop sponsored by the Oklahoma Aeronautics Commission; the SHARP Program, an eight–week program that allows students to work with Goddard Space Center scientists and earn minimum wages; Science Congress, a research–based competition for high school seniors, sponsored by the Wisconsin Society of Science Teachers and the Wisconsin Academy of Science; and an Invention Convention, for students in grades K–12, sponsored by the Oklahoma Department of Education and the Oklahoma Department of Commerce.

Beyond state–supported and state–level recognition programs, several national programs exist to recognize outstanding achievement in science and mathematics. These include the West Virginia National Youth Science Camp, U.S. Department of Energy Institutes, the Westinghouse Science Talent Search, the National High School Mathematics Examination and the National Junior High School Mathematics Examination. Dominos Pizza also sponsors a national Domino's Competition.

Special Schools

Only a handful of states solely support magnet or residential schools that provide specialized subject area study. Like recognition programs, special schools are more often supported through private organizations or through a combination of resources. Fifteen states report sponsoring, at least in part, schools that focus on science; two more states report that they are considering or proposing a special, science–oriented school. Twelve states report having special schools that focus on mathematics; one state is currently proposing such a school while yet another is developing one. Some states report having more than one special school and are mentioned below.

The state of Pennsylvania has a variety of special schools in a variety of subject areas, including science and mathematics. The Pennsylvania Governor's School for the Sciences, established at Carnegie–Mellon University with state and foundation monies, accommodates more than 90 students per year. Selection is competitive, based on SAT scores, GPA, class rank, teacher and counselor ratings and recommendations, and number and level of science and mathematics courses completed. The Pennsylvania Governor's School for Agriculture, located at Pennsylvania State University, focuses primarily on the sciences and technology in an effort to "shed its plow and cows image." Selection criteria are similar to those above. Some of the other states that report special schools include North Carolina, Louisiana and Virginia. The North Carolina School of Science and Mathematics is a residential school located in Durham, North Carolina. It provides students who have recognized aptitudes in science and mathematics with an advanced educational program and enriching atmosphere. The Louisiana School for Science, Mathematics and the Arts, established in 1983, is located in Natichitoches, Louisiana at Northwestern State University and is patterned after the North Carolina School for Science and Mathematics. Louisiana's school accommodates 700 talented high school juniors and seniors who are nominated by their school districts. In Virginia, state and local monies support four magnet

schools in science: the New Horizon Magnet School for Science, the Roanoke Governor's School for Science and Mathematics, the Thomas Jefferson High School for Science and Technology and the Central Virginia Governor's School for Science and Technology. Also supported by Virginia are six Summer Governor's Schools for Science and Technology. Approximately 3,000 students participate in these programs annually.

Summer Programs

Summer programs that provide additional opportunities to students to enhance their education are more popular among states than special schools (possibly because summer programs have a shorter duration and therefore cost less to operate). Summer institutes and special programs are offered in 20 states to students studying science; 19 states provide summer mathematics programs. Generally, summer programs last from one to six weeks and focus on a variety of subjects. For example, the state of Wisconsin sponsors Science World, a one-week, integrated physical science/biology/earth science program located at Pigeon Lake. Not only does this program provide exciting educational experiences for students, it also provides professional development experiences for teachers.

Six hundred students in North Carolina participated in Summer Ventures during the summer of 1987. Summer Venture programs, located at five different North Carolina university campuses, are five-week long residential workshops. Specific course offerings vary by program location, but the overall curriculum focuses on science, mathematics and the use of computers.

Some states do not host summer programs at all but rather participate in programs in other states. For example, American Samoa does not support its own summer programs, but its students are not denied the opportunity to receive additional training during the summer. Five to six students are selected from American Samoa by the University of Hawaii each year to participate in a six-week summer program that focuses on marine biology, oceanography, navigation and ecology.

Some states appropriate a relatively large amount of money for special summer programs. For example, Florida's state education agency received $1,213,465 in 1986-87 for summer programs. This appropriation is in accordance with recent Florida state legislation that allows the state education agency to award grants to public school districts, higher education institutions, museums and any educationally oriented, nonprofit organization to conduct summer camps for students in science, mathematics or computers.

Special Populations

More than one-half of the states report programs designed to increase the participation of special populations in science and mathematics: 29 states report programs that focus on science and 33 report programs that

focus on mathematics. Several of these programs aim to introduce women and minorities to career options based on science and mathematics. Programs of special interest include the Oregon Multi–Cultural Science Association, a program being organized by the state and the Native American Science Education Association with Chapter I monies. Multicultural studies in science and mathematics will be promoted. For example, biology will be taught from a Native American perspective.

Montana also emphasizes Native American issues in education. The Native American Olympiad is held annually. Students of Native American descent are encouraged to participate in this science– and computer–focused program.

In Colorado, participation of minority groups in science is stimulated through MESA (Minority Engineers and Scientists Association). Minority students in grades 7–12 are encouraged to develop strong backgrounds in science and mathematics and to pursue careers in technical areas.

The state of Nevada promotes equity in education through "Odds on You" mathematics workshops. During these sessions, young women are encouraged to enroll in advanced mathematics classes and to pursue mathematics–related careers.

In 1986, Georgia's Department of Education and Board of Regents conducted 14 Futurescape seminars at colleges and universities throughout the state. These seminars allowed young women at the high school level to meet professional women whose careers are dependent on an educational foundation in science and mathematics. Funding at the state level terminated after 1986; however, some colleges continue to fund and conduct Futurescape seminars.

Wisconsin's Science World, noted in the previous section on summer programs, does more than link student learning with teacher training. During the selection process, priority is given to minority and handicapped students. Furthermore, 50% of its participants are women.

Some programs that serve special populations are reported by more than one state. "Expanding Your Horizons in Science and Math" are conferences held in Colorado and Montana. During Horizon conferences, young women are made more aware of career opportunities in technical fields, such as engineering and computer science. The EQUALS program, reported by North Carolina and New Hampshire, also focuses on women, particularly in the area of mathematics.

In addition to women and minorities, special populations include gifted and talented students. Too often the needs of these students are overlooked, resulting in their loss of interest in school and possibly dropping out of school. Colorado's reform effort, the 2+2 Project, plans as part of its initiatives to improve educational opportunities for gifted and talented students. More specifically, 2+2 plans to offer a " . . . renewed commitment to building science experiences that ensure gifted and talented students are intellectually nourished."

The state of Mississippi also plans to enhance the education of gifted and talented students. The legislature recently approved the establishment of a special boarding school for gifted high school juniors and seniors that will focus on science and mathematics. The school is scheduled to open for the 1988–89 school year.

Student Assessment

States have responded to the public pressure for accountability. Forty–six of the states (including American Samoa) have a statewide testing program. Of this 46, 30 assess science knowledge and 43 assess mathematics knowledge. Only five states (Alaska, Montana, Nebraska, Ohio and Vermont) delegate educational accountability responsibilities to school districts or schools themselves. This is an adjustment recently made by Alaska and Montana.

Teacher Shortages

Two types of teacher shortages were reported in the states: a shortage of teachers and a shortage of qualified teachers (teachers whose subject matter background is insufficient). In science, 17 states report a shortage of qualified teachers while 20 report a shortage of teachers in terms of quantity. Six of these states, Arkansas, Iowa, Pennsylvania, Texas, Virginia and West Virginia, report teacher shortages specifically in the areas of physics, chemistry or earth science or some combination of the three. In mathematics, 14 states report a shortage of qualified teachers while 25 report a shortage of teachers in terms of quantity. Several respondents qualified their answers by adding that teacher shortages weren't statewide but confined to small, rural districts.

Conversely, New York reports that its teacher shortages occurred primarily in large, urban districts. Pennsylvania is the only state that reports a shortage of qualified substitute teachers in mathematics.

Most states, aware of teacher shortages, have made some attempts to alleviate them. For example, Connecticut combats teacher shortages with higher teacher salaries, a loan program available to physics and mathematics teachers and continued staff development.

Iowa has an extensive array of programs designed to reduce and prevent teacher shortages. Examples include the Iowa Science and Math Loan Program, designed to assist current teachers to obtain or upgrade their teaching authorization in science or mathematics. The state may grant loans for up to $1,500 if students are enrolled at least part–time in an appropriate course of study. Loan recipients receive full loan cancellation benefits if they teach science or mathematics in an approved Iowa school for at least two years.

Profits from Iowa's lottery provide teachers with tuition, materials, room and board and a $150 per week stipend if they participate in the Iowa

Lottery Funds to Revitalize Current Mathematics and Science Teachers summer program. Four summer institutes were held during the summer of 1987 and four more are being planned for the coming year.

Mississippi is using a very familiar means to cope with teacher shortages -- the television. A pilot plan is under way that delivers science instruction via satellite to classrooms that lack teachers.

Teacher Recruitment

As was indicated above, classroom teachers are becoming a scarce commodity, especially in science and mathematics, due to higher salaries and better working conditions in the private sector, retirement and natural attrition. In Florida alone, it is predicted that one-third of the mathematics teaching force will retire in the next five years. Recruitment efforts must gear up to avoid these predicted teacher shortages.

Current recruitment strategies vary from state to state. However, the most common strategy, as identified by survey respondents, is a forgivable loan program. Twenty-five states report a loan program for persons who receive teacher training in science or mathematics. Loan programs are either for undergraduates who become certified for the first time or current teachers who become recertified. The Iowa Science and Mathematics Loan Program, described in the previous section, is a classic example.

Closely related to loan programs are scholarship programs. Seven states report scholarship programs for potential science teachers and six report scholarship programs for potential mathematics teachers. For example, Idaho uses Title II monies to provide scholarships to potential science or mathematics teachers or teachers who want to become recertified in one of these subject areas. Similarly, American Samoa's Department of Education offers scholarships to science majors who enter the teaching profession.

Another typical recruitment strategy is alternative certification. (For the purposes of this survey, alternative certification means full certification despite a lack of traditional credentials.) Only 12 states offer an alternate route to certification in science and only 10 offer an alternate route in mathematics. In Maine, certification may be granted to qualified persons following a transcript analysis and completion of only six semester hours of educational course work. (Depending on the transcript analysis results, additional course work could be prescribed.) In Utah, Eminence Certificates are available to professionals such as doctors and engineers. An Eminence Certificate allows them to teach up to two class periods per day. Some states do not provide an alternate certification program but allow districts to do so. For example, the state of Texas allows its districts to develop their own alternate certification programs given a documented or projected need.

These three types of recruitment strategies -- loans, scholarships and alternative certification -- are often effective but rather basic.

Several states have developed more innovative ways to recruit people into the teaching profession.

By dialing 1–800–FL–TEACH (an in–state number) or 1–800–TEACH–FL (an out of–state number) interested people can receive teacher recruitment referrals for the state of Florida. In addition, the Great Florida Teach–In occurs each June to help teachers find jobs in Florida. This program has a relatively high success rate; of the 1,500 teachers who attended the 1986 teach–in, over half were offered teaching positions.

California and Georgia participate in a novel recruitment program that simultaneously promotes cultural exchange. Both states actively recruit science and mathematics teachers from West Germany.

Another teacher recruitment and public awareness campaign in California is headed by Bill Honig, Superintendent of Public Instruction, and Ann Reynolds, the head of the California State University system. During visits to universities with teacher preparation programs, Superintendent Honig encourages students to "Be a Class Act: Be a Teacher" and explains the rewards of teaching and provides general information about the profession.

Teacher Training and Retention

After states successfully recruit people into the teaching profession, the next task is to keep them there. With fierce competition from the private sector, this task is often very challenging. Twenty–six states report having some type of teacher training or retention program for science and mathematics teachers. Approximately half of these programs involve loans and scholarships to promote additional course work (similar to those used to recruit teachers). The other half is divided among a variety of programs. Exemplars include the Teacher Summer Business Training and Employment Program in New York that provides a portion of salary reimbursement for science, mathematics, computer or occupational education teachers employed by business and industry during the summer months.

In Kentucky, Title II funds support the Science Improvement Project (SIP) for physical science teachers at the secondary level. The state has hired an outstanding physics teacher to serve as a consultant to schools within the 5th and 7th Congressional districts. (These districts were chosen due to low income levels and low achievement scores.) The consultant will show physics teachers in these districts how to teach science more effectively, how to use mathematics in teaching science and how to integrate computers into science instruction.

Staff Development Needs

Perceived weaknesses in teaching skills among science teachers fall into three main categories: content, methodology and curriculum. More specifically, within the area of science content, elementary teachers were

identified as needing the most staff development, especially with experiments and working with hands–on materials. Middle school teachers need general content training. Likewise, cross–over teachers at the high school level, or those who teach science but are officially certified in another subject area, need general content training. High school teachers who are officially certified in science need the content training necessary to teach lower level science, chemistry, physics and earth science.

Within the category of methodology, all science teachers need training in the use of hands–on instructional approaches, manipulatives, higher order thinking skills, problem solving and small group projects. Several states are concerned that "particularly elementary teachers [lack and need] experience with inquiry and activity–oriented teaching."

Identified staff development needs in terms of science curriculum issues include curriculum development, establishment of goals, coordination of the curriculum and assessment tools, curriculum coordination between grades K–12 and integration of science with other subjects. One respondent remarked, "It is crucial that teachers teach from an integrated approach in terms of both grade level and different subject areas."

Identified staff development needs among mathematics teachers also fall into three categories: content, methodology and currency. All mathematics teachers need staff development in higher order thinking skills, problem solving, inquiry skills and estimation. Elementary teachers especially need training in problem solving and higher order thinking skills.

Staff development needs in terms of methodology include problem solving, integration, use of manipulatives, applications, serving students' needs and small group projects. Elementary teachers especially need training in manipulatives and hands–on experiences; high school teachers need training

in consumer applications. The use of technology in teaching mathematics is a special methodology issue expressed by several states as a staff development need.

Currency issues, or bringing mathematics teachers "up–to–date," is another identified staff development need. Teachers at all levels need to learn of current research, content and teaching techniques. Mathematics teachers also need to be updated in terms of higher order thinking skills, statistics and probabilities, manipulatives and applications.

Trends and Issues

Survey respondents were asked to identify major problems that their states face in improving science and mathematics instruction; many of their answers echo those included in the previous section on staff development needs.

Trends, problems and concerns about science mainly evolve around teachers' issues, school–wide issues and funding issues. The majority of concerns have to do with teachers and teaching. Ten states voice a concern for improving science content especially in the areas of physical science and lower level science. "Providing guidance to teachers of 'slower classes'" is especially difficult. Thirty states note concern for methodology among science teachers; half of these states stressed concern with methodology at the elementary level followed by emphasized concern at the middle school level. Given this information, it may be that teachers know how to teach the subject of science but they do not know how to teach science to young children. Evidence of this comes from several states, including California, Connecticut, Louisiana, Michigan, Montana, New York, South Dakota and Vermont. Montana recently conducted a statewide needs assessment in science, mathematics and computer education. One of the identified needs is that "elementary teachers need to more fully understand the use of hands–on, inquiry and activity approaches in teaching science."

One respondent in New York commented that "science programs at the middle/junior high school level lack concrete, "hands–on" activities related to the real world."

Many other teachers issues were cited. Fifteen states expressed a real concern about negative teacher attitudes toward science; they need to understand " . . . the real mission of science which is teaching science as a creative, inventive endeavor." This is particularly true among elementary teachers who combine this apathetic attitude with anxiety toward teaching science. One respondent commented that if elementary teaches had " . . . more content knowledge in areas of science, [this would help] to overcome the anxiety they feel." Another respondent feels that " . . . instilling confidence in elementary teachers [will] make teaching science less stressful." However, one respondent said it best: "If [society] had as much interest in science as [it does] in athletics, the science program would be pretty well off."

Another identified concern reported by several states is one of teacher shortages. As was noted earlier in this summary, 37 of the states report a shortage of science teachers in terms of either quality or quantity. This is a serious situation since only six states noted a concern about ongoing training to upgrade the quality of current teachers and only three states voiced any concern about recruiting new persons to teach science. Other teacher issues identified by respondents include textbook dependency, cross–over teaching and lack of adequate preservice preparation.

Beyond concerns about teaching and teachers were school–wide issues. Large class size topped the list, followed by lack of time for science, laboratory safety, special needs of students and equity. One state legislature has addressed the lab safety issue by passing a "Right to Know" law that is prefaced on the right of the public to know about the hazards of chemicals with which students and teachers may come in contact.

According to one respondent, "The intent of the legislation is good . . . but there is a lot of red tape and paperwork involved that takes time away from instruction."

Lack of funding was reported by 39 of the states as a major issue. Half of those states specifically cited lack of funding for materials and updating laboratories as a major problem. Lack of funding for staff development and teacher salaries was also specified as crucial.

Problems and concerns relating to mathematics instruction can also be classified in terms of teachers issues, school–wide issues and funding issues. As with science problems, the majority of concerns have to do with teachers. Twelve states express concern that " . . . mathematics teachers lack adequate content knowledge . . . particularly in the areas of low ability and remedial instruction." Sixteen states report problems in terms of teaching methods. One respondent stated that "mathematics teachers lack the necessary skills to deliver quality mathematics instruction especially where computers and other technologies are concerned." Another respondent added that "mathematics teachers need to learn alternative strategies for teaching mathematics; it can be made exciting and dynamic."

Teacher attitudes toward mathematics, again like science, are dangerously negative. Eleven states expressed concern that there needs to be a clearer understanding of the total scope of mathematics. Teachers just "don't have a clear understanding of what mathematics is . . . and apparently don't care." For example, in Pennsylvania, only 5–10% of the teaching population attends statewide mathematics workshops on a regular basis. Not surprisingly, several states report problems in terms of participation in staff development.

School–wide issues related to mathematics are again similar to those related to science. Inequity and lack of time for planning are reported by a few states as barriers to improving mathematics instruction. In terms of inequity, one respondent stated, "We cannot continue to ignore the needs of historically underrepresented and underserved groups . . . their needs must be met."

Several funding issues are reported that relate to mathematics instruction. Nine states report a lack of funding for obviously needed staff development. Other states report lack of funding for materials and teacher salaries.

ALABAMA

CURRICULUM

Curriculum Guides

The required Alabama Course of Study: Science K-12 sets minimum guidelines, outlines course content and suggests student activities. The course of study was developed by a statewide committee of science educators. This document is reviewed and revised if necessary every four years.

The state also has a Course of Study: Mathematics K-12 and mathematics curriculum guides that include outcomes. The course of study was developed by the mathematics work group of the state Course of Study Committee, and it is required. The curriculum guides were developed by Alabama classroom teachers in conjunction with State Department of Education specialists, and they are recommended. The course of study for grades K-12 were last revised in 1984; the curriculum guides were last revised in 1986.

Higher Order Thinking Skills

Higher order thinking skills have been emphasized in all areas. District and statewide workshops have been conducted and demonstration lessons have been taught.

Time Requirements

Thirty minutes per day of science instruction are required for grades K-3, 125 minutes per week for grades 4-6 and 300 minutes per week for grades 7-12.

For grades 1-6, 225 minutes per week of mathematics instruction is required. For grades 7-12, 250 minutes per week is required. In those schools where grades 7 and 8 are housed with other elementary grades, the school may follow the time requirements for grades 4-6 or the time requirements for grades 7-12.

Graduation Requirements

Alabama has two types of high school diplomas, the Standard Diploma and the Advanced Diploma. The minimum course criteria for science and mathematics requires three science credits consisting of life sciences, physical sciences and an elective, and two mathematics credits; computer literacy requires one-half credit. Students must pass the Alabama High School Graduation Examination (AHSGE) before receiving a diploma.

STUDENTS

Recognition and Awards

Students with a special interest in science may participate in the Alabama Science Olympiad.

There are no state-sponsored recognition programs for students in mathematics. Recognition programs are sponsored at the district level.

Summer Institutes, Magnet and Residential Schools

There are no state-sponsored special schools or summer programs for students in science or mathematics.

Special Populations

There are no state-sponsored programs designed to increase the participation of women and minorities in science or mathematics.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

The Otis-Lennon School Ability Test (OLSAT), given in grades 1, 2, 4, 5, 8 and 10, measures a student's ability to perceive, to recognize and recall what has been perceived, to think logically and abstractly, and to perceive and generalize relationships.

Assessment Content

The Alabama Basic Competence Test (BCT) and the Alabama High School Graduation Examination (AHSGE) measure the mastery of basic skills outlined in Alabama's Courses of Study.

Assessment Reporting

Assessment results are reported for the state, districts, schools and students.

The Alabama Basic Competency Test (BCT) results are used as checkpoints at grades 3, 6 and 9. The Alabama High School Graduation Examination (AHSGE) is used to ensure that students who receive a diploma have acquired minimum knowledge in the basic skill areas of reading, language arts and mathematics. The Stanford Achievement Test (SAT) allows comparison of students with their peers on a school, district, state and national basis. The School Ability Index indicates a student's ability to handle school-related material. The Otis-Lennon School Ability Test (OLSAT) results are reported as one score. The OLSAT makes it possible to compare SAT scores of students with those of other students with the same ability.

Subject Areas Assessed

In 1987, the BCT will be given in grades 3, 6 and 9 and will determine if students have mastered the basic skills in reading, language arts and mathematics appropriate for their grade levels. The AHSGE will be given in grades 11 and 12 to ensure that graduating students have mastered basic skills in the same areas. The SAT will be given in grades 1, 2, 4, 5, 8 and 10 and will test student achievement in the areas of reading, language arts, mathematics, listening, science and social studies.

TEACHERS

Teacher Recruitment and Retention

Fifty thousand dollars was allotted in 1983-84 to implement a loan scholarship program. The allotment was increased to $600,000 in 1985 and $1.2 million in 1986. Students may receive up to $4,000 per year for two years if they are receiving training in shortage areas. In 1985, 198 students participated in the loan program. Mathematics education majors received 66% of the loans; general science education majors, 13%; physical science education majors, 11%; and biology education majors, 10%.

Teacher Shortages

Alabama has a shortage of science teachers which the state is addressing through the loan program described above.

While mathematics is considered a critical area in the state, shortages do occur, mainly in the small, rural districts. To help alleviate these shortages, mathematics certificates, renewable three times, are granted to certified teachers who have six semester hours or nine quarter hours of mathematics to permit them to teach while they are acquiring additional mathematics credits.

Certification Requirements

Alabama has teaching certificates for early childhood education, elementary school, middle school, high school and nursery through grade 12. Twelve semester hours of natural and physical sciences, including mathematics are required for all of these certificates. Neither science or mathematics requirements are specifically included in the professional studies leading to sixth and seventh year certification for teachers or the instructional support personnel in professional studies leading to fifth, sixth and seventh year certification.

Alternative Certification

Persons with provisional certificates may be assigned to teach in critical shortage areas if a regularly certified teacher is not available. However, the provisionally certified person must have a bachelor's degree in the subject areas to be taught.

Teacher Training

To upgrade the skills of science and mathematics teachers, summer institutes are sponsored, inservice training is provided and workshops are held.

Staff Development Needs

Teachers need additional training for effective utilization of technology in the classroom. Teachers also need training in the utilization of manipulatives in the teaching of mathematics. In many of the Alabama school systems there is a need for better coordination of the mathematics programs and closer supervision of actual classroom instruction. Teachers want and would benefit from constructive feedback concerning course content and instructional techniques.

FUNDING

School systems use Title II funds for teacher inservice programs in science, mathematics and foreign language. Small amounts are spent on materials.

RECENT STATE REFORMS/NEW INITIATIVES

The Plan for Excellence has increased the number of mathematics units required for graduation from high school to two and has recognized the Advanced Diploma that requires additional science and mathematics courses at a higher level.

TRENDS AND ISSUES

To upgrade science instruction, the state needs to update science laboratories and to educate administrators on the importance of science education. To improve mathematics instruction, more money is needed for the employment of mathematics supervisors in each school system, for additional staff development and to purchase materials and equipment.

ALASKA

CURRICULUM

Curriculum Guides

Alaska Model Curriculum Guides for science and mathematics contain concepts, learning outcomes/objectives and sample learning activities. The guides were developed by the state education agency with assistance from state professional organizations; they serve as a technical assistance model to be used at district discretion. These curriculum guides were revised for science and mathematics in 1987 and are available for grades 1 through 12.

Higher Order Thinking Skills

The state's curriculum guides emphasize higher order thinking skills. In addition, the Alaska Math Consortium is a collaborative training effort coordinated by the state education agency that includes universities and 11 local education agencies. One of the thematic strands of all instruction sponsored by the consortium is problem solving.

Time Requirements

There are no state requirements or recommendations regarding the amount of time spent on science instruction. The amount of time recommended by the state to be spent on mathematics instruction is as follows:

Grades 1-3 — 60-225 minutes per week
Grades 4-6 — 175-250 minutes per week
Grades 7-9 — 250-300 minutes per week
Grades 9-12 — 250 - 300 minutes per week

Graduation Requirements

The minimum course study in Alaska for science is two units and for mathematics is two units. These requirements represent a one-unit increase in each, effective since 1985. No changes in these requirements have been recently proposed.

STUDENTS

Recognition and Awards

There are no specific recognition programs in either science or mathematics. However, a Math Counts competition is organized at the middle school level. Students also participate in the State Science Fair and the science and mathematics components of the Academic Decathalon competition.

Summer Institutes, Magnet and Residential Schools

Alaska does not support summer institutes, magnet or residential schools in science or mathematics.

Special Populations

The Math Consortium's recruitment program focuses on addressing the needs of women and minorities. Universities offer some special science fellowships and incentive programs for special populations.

STUDENT ASSESSMENT

Alaska's last statewide assessment was in 1985; the state no longer conducts statewide assessment of students. (Information regarding the scope and focus of the former assessment program is available.) The assessment program was discontinued because of lack of funds caused by declining oil revenues. There are no present plans to start a new program, but the Department of Education is exploring ways to measure student progress in lieu of a statewide assessment.

TEACHERS

Teacher Recruitment and Retention

Loans of $5,500 to all undergraduates and $6,500 to all graduates are available for up to four years. Up to 50% of the loan can be canceled after five years of Alaska residency after graduation. This program was adopted in 1972.

Teacher Shortages

Teacher shortages in science vary by discipline. A majority of science teachers are teaching outside of their degree areas. Only 35% of mathematics teachers have a certificate endorsement, but school districts are currently laying off teachers because of budget reductions and are not recruiting new teachers at this time.

Certification Requirements

Teachers must be recommended by an accredited institute of higher education to receive either elementary or secondary certification. The state does not have content requirements in science or mathematics; therefore, a teacher's background is dependent on the institution's requirements.

Alternative Certification

An Emergency Teaching Certificate is granted in an extreme emergency to an applicant who does not meet the requirements of a regular certificate. An Emergency Teaching Certificate is available to people who have earned bachelor's degrees or have completed teacher education programs, including student teaching or two years of classroom teaching in grades K-12. However, the school district superintendent, the Commissioner of Education and the Director of Certification must unanimously verify that there is a situation within the district that warrants granting emergency certification. Two people took advantage of the program in the past year.

Teacher Training

The state has initiated a project to integrate computers in the classroom to encourage process science in human affairs. Alaska is also cooperating with the university and

professional associations on an audio-conference course and a one-summer course in science. The Department of Education coordinates minerals education training that is sponsored by the mining and oil industry. The Alaska Math Consortium is a collaborative training effort coordinated by the state education agency that involves universities and 11 local education agencies.

Staff Development Needs

School districts have identified a need for training to help develop more process and hands-on instruction in science as well as knowledge of science topics relative to Alaska. The greatest staff development need among mathematics teachers is the training of teachers who teach out-of-subject areas and cover multiple disciplines or grade levels in small rural schools.

FUNDING

Nine districts have formed a consortium for in-depth training and follow-up in process science using Title II funds. Others have sponsored one-day or half-day science inservice programs or sent their teachers to state or national science education conferences. Some block grant funds were available for Science Teacher Incentive Grants.

Districts typically use Title II funds for one-day science or mathematics inservice programs or to join the Alaska Math Consortium. No additional state monies or resources have been made available to districts to target mathematics instruction.

RECENT STATE REFORMS/NEW INITIATIVES

No new state reforms or initiatives that have affected science or mathematics instruction were reported.

TRENDS AND ISSUES

According to a recent survey of the school districts, the three most urgent needs in science education are:

1. Upgrading the district curriculums;
2. Improving achievement and representation for rural science students; and
3. Upgrading deficient facilities, equipment and supplies.

Mathematics problems identified in Alaska include:

1. Teaching loads in small rural schools often cover many grade levels or multiple disciplines;
2. Cultural appropriateness (or inappropriateness) of traditional mathematics instruction for Eskimo, Indian and Aleut students; and
3. Identification of a more relevant and current curriculum.

AMERICAN SAMOA

CURRICULUM

Curriculum Guides

American Samoa has required guidelines and objectives by grade level and course, including science and mathematics. The guidelines were developed by curriculum staff and committees of teachers and were last revised in March 1987 for grades 1-12.

Higher Order Thinking Skills

Currently, there is only verbal encouragement of higher order thinking skills. However, workshops are being planned and will be presented on critical thinking skills. These workshops are primarily aimed at elementary teachers.

Time Requirements

There are no guidelines or requirements regarding the amount of science instruction students receive.

Graduation Requirements

Effective as of September 1986, three units of science are required for high school graduation.

STUDENTS

Recognition and Awards

Several programs exist that recognize outstanding student achievement in science. The Department of Education, in collaboration with businesses, sponsors the Science Fair. The Department of Education also sponsors the Student Marine Symposium in conjunction with the Hawaii Academy of Science. National Institutes of Health Centennial Scholar programs also recognize outstanding achievement in science.

Summer Institutes, Magnet and Residential Schools

There are no territory-supported special schools for students studying science. However, five to six students are selected by the University of Hawaii to participate in a six-week summer program that focuses on marine biology, oceanography, navigation ,ecology, etc.

Special Populations

The territory does not support special programs to increase the participation of underrepresented groups in science.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

American Samoa is addressing higher order thinking skills in its assessment program by constructing curriculum-referenced test items that are problem solving and application oriented in nature.

Assessment Content

Curriculum-referenced test items are related directly to curriculum objectives by subject area.

Assessment Reporting

Assessment results are reported for the state, schools and students. These results are made public.

Assessment results are intended to be used by schools to improve instruction, by districts to improve curriculum and by state education policy makers to improve overall education.

Subject Areas Assessed

In 1987, all students in grades 3, 5, 8 and 12 were tested in all core areas, which are science, mathematics, social studies, language arts and reading. In 1988 through 1990, all students in grades 3-12 are scheduled to be tested in all core areas.

TEACHERS

Teacher Recruitment and Retention

There have been no recent initiatives implemented by the territory to attract or retain science teachers.

Teacher Shortages

There is a shortage of science teachers in American Samoa. To address this shortage, the Department of Education offers scholarships to science majors who go into teaching.

Certification Requirements

There are no certification requirements in American Samoa at the elementary or secondary levels. However, in hiring, people with either science degrees (often pre-med or nursing) or science education degrees are sought.

Alternative Certification

There is no certification available in American Samoa, thus no alternative route is necessary.

Teacher Training

Inservices are provided to upgrade the skills of science teachers. Bachelor's and master's programs are also offered through the University of Hawaii. However, few courses in science are available.

Staff Development Needs

At the elementary level, teachers need content courses/workshops that parallel the territory's curriculum. At the secondary level, teachers need methods and education training, as well as upgraded content knowledge.

FUNDING

Title II funds are incorporated into American Samoa's block grant and not specifically spent on science instruction.

RECENT STATE REFORMS/NEW INITIATIVES

There have been no recent reforms that have promoted or hindered science instruction.

TRENDS AND ISSUES

The biggest problems that American Samoa faces in improving science instruction include the lack of funds available for textbooks and lab materials and the lack of science education that is offered in the territory's bachelor's programs.

There are efforts under way to increase territorial local funding. Policy makers are also negotiating to incorporate more science and mathematics into the bachelor's programs, as well as territory-wide inservices. American Samoa also applied for a National Science Foundation grant to be able to provide teacher training in science and mathematics, but this was not funded.

ARIZONA

Arizona did not provide answers to the specific questions related to mathematics.

CURRICULUM

Curriculum Guides

In 1984, the Essential Skills Committee, consisting of educators, representatives from the Arizona Department of Education and representatives from the general public, developed recommended learner outcomes for grades K-12.

Higher Order Thinking Skills

Two National Science Foundation grants have been awarded to two professors at Arizona State University. The first was awarded to Tony Lawson for a project on the development of reasoning. The second was awarded to Fred Staley to develop curriculum materials and to train resource people in 42 schools in the areas of science and technology literacy. These curriculum materials combine thinking skills and reasoning skills. The state department has a teacher training program that emphasizes the teaching of thinking skills in the science classroom. Teachers can receive graduate credit through Northern Arizona University for participating in this program.

Time Requirements

Arizona requires that both science and mathematics be taught; each local district determines the appropriate amount of time the subjects are taught.

Graduation Requirements

Arizona school districts have the option to require competency testing of students prior to graduation. Beginning with the class of 1987, two units are required in science and mathematics. The Board of Regents recently made a ruling that changed the courses that are acceptable for college admission. Universities no longer accept earth science as a science; only chemistry, biology and physics (two of these must be a laboratory class) are acceptable. This is affecting enrollment in earth science classes in the state. As a result, some districts have discontinued their earth science programs and others have reduced the number of earth science classes offered. Universities no longer accept pre-algebra or general mathematics as meeting the mathematics requirement.

STUDENTS

Recognition and Awards

Students from Arizona participate in national programs. Teams of 8th grade students participate in the Science Challenge Day that is held annually in Maricopa County. This program is similar to the Science Olympiad. Arizona sends delegates to the West Virginia National Youth Science Camp; in addition, the state sent four students to Honor Summer Institutes at national labs. The Arizona Association of Teachers of Mathematics holds a state mathematics contest each year for grades 9-12. Mathematics contests and the Math Olympiad are popular around the state.

Summer Institutes, Magnet and Residential Schools

The Arizona legislature recently appropriated $50,000 to the Board of Regents to establish science and mathematics centers at state universities for outstanding high school students. Centers coordinate course work and counseling for students in cooperation with high school teachers. Students are selected on the basis of merit and need. Some funding is supplied for tuition and living expenses.

Arizona State University is one of three universities that receives state funding to develop a summer program for gifted middle school/junior high school students. The summer program is primarily supported by the university rather than by the state. Students submit applications for enrollment and are selected by program coordinators. An estimated 200-300 7th and 8th grade students participate each year. Programs that may last up to 16 weeks focus on chemistry, physics and other areas of science. There are several magnet schools for science and mathematics located around the state. Two examples are Booth-Fickett Junior High School in Tucson and Phoenix Union High School District.

Special Populations

Through Title II funds, the state supports Summer Career Awareness Institutes at Northern Arizona University for girls and minorities in 8th grade. Some professional organizations, such as the Women's Engineering Association, hold Career Awareness Days in science and mathematics for high school girls only. The Department of Education partially funds these programs.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

Higher order thinking skills are not included in the state's assessment program.

Assessment Content

The assessment content and the essential skills are not coordinated.

Assessment Reporting

Assessment results are reported for the state, districts, schools and students. Results for the state, districts and schools are made public.

Schools use assessment results to determine student and group strengths and weaknesses by skills objectives that match the local curriculum. Districts use results to determine group strengths and weaknesses. State education policy makers do not currently use assessment results. There is a proposal to identify "at risk" students in grades 1-3 to provide funding to local districts to further assist these students.

Subject Areas Assessed

A sample of students in grades 4, 8 and 11 (1,000 per grade) take a writing assessment every three years. Every student in grades 1-8 take the Iowa Test of Basic Skills annually. Every student in grades 9-12 take the SAT-7 annually. This testing schedule is not expected to change.

TEACHERS

Recruitment and Retention

The state of Arizona does not have many problems attracting or retaining science and mathematics teachers; therefore, there are no new programs to serve this purpose. However, there is a federally funded program located at Northern Arizona University that is training 20 teachers in science and mathematics at the middle school level.

Teacher Shortages

Arizona does not have a shortage of science or mathematics teachers.

Certification Requirements

Only a science methods course is required for certification at the elementary level (K-8). Certification at the secondary level (9-12) requires a major in science or 30 semester hours of science course work. People may also teach science with a minor; however, the number of courses that can be taught by a person holding a minor in science is limited. (Districts determine this limit.) The same holds true for mathematics.

Alternative Certification

A program that is cosponsored by universities and the State Department of Education allows people with degrees in science who lack education experience to complete an accelerated curriculum and receive their education degrees.

Teacher Training

To upgrade the skills of science teachers, the state supports a summer academy for science and mathematics teachers from rural areas, ongoing teacher training programs and five workshop programs that are each 15 hours in length. Universities also offer summer programs to upgrade teaching skills.

Staff Development Needs

The greatest staff development needs among science and mathematics teachers include teaching thinking and reasoning skills and using cooperative/group learning strategies. Mathematics teachers further express a need for help in teaching problem solving using manipulatives and effective use of calculators.

FUNDING

Districts are using Title II funds in a variety of ways, including workshops for teachers, expenses associated with teacher visits to business and industry work sites, and equipment.

No additional state monies targeted to science and mathematics have been made available to districts.

RECENT STATE REFORMS/NEW INITIATIVES

There have been no recent state reforms that have either promoted or hindered science or mathematics instruction, although the legislature has approved funding for a science and a mathematics specialist at the Department of Education.

TRENDS AND ISSUES

The three biggest problems that the state of Arizona faces in improving science and mathematics instruction are:

1. Combining resources, including those of universities and the State Department of Education;
2. Sharing information through the use of technology (the state is planning to use the CSO/IBM system; and
3. The lack of clear guidelines from the State Department — the essential skills need to be revised in science (mathematics was just completed).

All of these issues are currently being addressed.

ARKANSAS

CURRICULUM

Curriculum Guides

In 1985, the following Course Content Guides for Science were developed by master teachers, principals, university science professors, science education teachers and a Department of Education science specialist: K, 1, 2, 3, 4-6; 7th grade life science; 8th grade earth science; physical science; biology; chemistry; physics and general science. The content guides specify skills at three levels of complexity: basic, developmental and extension skills.

Course Content Guides were also developed in 1985 for mathematics by the Department of Education in conjunction with appointed committees that included teachers, administrators, teacher educators from higher education and the Department of Education Mathematics Specialist. The guides are required for grades K-12 and will be revised on a five-year rotating schedule.

Higher Order Thinking Skills

The "Extension Skills" that are included in the content guides for science and mathematics are designed to promote higher order thinking skills. A series of workshops that focus on teaching problem-solving techniques has been conducted by a State Department of Education specialist.

Time Requirements

State guidelines require grades 5 and 6 to have 150 minutes per week in science instruction, provided that these grades are clustered in an elementary school (any combination of grades K-6). The guidelines require middle schools to teach 200 minutes per week in science instruction (middle school grades may include any combination of grades 5-8, but the most common inclusion is grades 7 and 8). Classes for students in grade 9-12 must meet a minimum of 250 minutes per week.

State guidelines require that students in grades 1-3 receive at least 225 minutes per week of mathematics instruction. Students in grades 4-6 must receive 300 minutes per week of mathematics instruction, and students in grades 7-12 must receive 250 minutes per week.

Graduation Requirements

To graduate from high school, Arkansas students must complete five units of science and mathematics (at least two units must be taken in science and two in mathematics). Districts may allow graduation credit for educational experiences outside the traditional classroom, which may include courses at higher education institutions.

No changes in these requirements are being proposed.

STUDENTS

Recognition and Awards

Arkansas students participate in national recognition programs such as the Westinghouse program, computer camps, the West Virginia National Youth Science Camp, U.S. Department of Energy Science Institutes, etc.; there are no state-level programs to date.

Mathematics students in grades 9-12 participate in regional and state competitions sponsored by the Arkansas Council of Teachers of Mathematics. Winners in each of five categories receive awards. State winners in the upper two categories (usually high school seniors) receive scholarships. Students in grades 7-8 participate in regional and state competitions of Math Counts, which is sponsored by the Society of Professional Engineers. The mathematics specialist in the Department of Education serves as an advisor to both of these sponsoring groups.

Act 35 of 1983 established the Arkansas Department of Education's Recognition Program, which is designed to recognize outstanding achievement of students, teachers and schools across the state. The components of the program specifically for students include the Student Recognition Program, the Master Learner Program and the Governor's Academic Competition, more commonly known as the Arkansas Quiz Bowl. These programs encompass all subject areas.

The Student Recognition Program awards grants of up to $2,000 to schools or districts with exemplary student recognition programs already in operation. This component was designed to encourage other schools and districts to develop student recognition programs.

The Master Learner Program awards five plaques statewide to students who have made outstanding academic improvement in a given school year. This program was designed to encourage all students to strive for academic excellence.

The Arkansas Quiz Bowl invites every public high school in the state to enter a four-member team in the competition that tests quick recall and general knowledge facts. Regional competitions are held and top winners advance to the state competition. The state-level Quiz Bowl is held annually at the Arkansas Educational Television Network studios in Conway. Prizes include trophies for schools and individuals, scholarships and the opportunity to participate in a National Quiz Bowl.

Summer Institutes, Magnet and Residential Schools

The Arkansas Governor's School summer program offers courses in mathematics, science, fine arts, computer science and social sciences to approximately 500 high school students each year.

Summer programs for gifted and talented students are offered by a number of institutions representing a collaboration between the Department of Education, local school districts, regional service centers and higher education institutions. These programs last from three to five weeks.

Special Populations

The Department of Education recently studied the participation of underrepresented groups in the content areas of science and mathematics. This study will attempt to determine the extent to which minorities and women are electing the study of higher level science and mathematics courses at the junior high and high school levels. This study should assist in determining the extent to which inservice and other types of curriculum intervention are needed to encourage these underrepresented groups to participate fully in the science and mathematics curriculum of the school. (The study is complete as of July 1987.)

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

The MAT6, used by Arkansas, reports achievement of higher order thinking skills on each student report. The state-constructed Minimum Performance Test only addresses basic skills.

Assessment Content

Teachers analyzed the norm-referenced tests for a curricular match before recommending the MAT6. The Minimum Performance Test directly assesses state-adopted basic skill objectives.

Assessment Reporting

Assessment results are reported for the state, districts, schools and students. Results for districts are made public.

Assessment results are intended to provide teachers with diagnostic information to measure student performance in basic subjects and to identify students who have not mastered basic skills. Assessment results are also used to identify those school districts in which less than 85% of the students demonstrate mastery of basic skills. This provides data concerning the strengths and weaknesses of the instructional programs within those districts. Furthermore, assessment results provide information to districts for educational planning and decision making. State policy makers use assessment results to measure progress relative to the educational reforms that have been legislated.

Subject Areas Assessed

Currently, mathematics and reading skills are annually tested in grades 3, 4, 6, 7, 8 and 10. Social studies, language arts and science skills are annually tested in grades 4, 6, 7, 8 and 10. Subject areas and grade levels tested will remain the same from 1987 through 1990, except for possible addition of language arts testing at grade 3.

TEACHERS

Teacher Recruitment and Retention

There is some state and private funding available to prospective science and mathematics teachers.

Teacher Shortages

The state currently has a shortage of physics and chemistry teachers. To help solve the problem, biology, physical science and other science teachers are being retrained to teach physics and chemistry.

There are geographic areas within the state that have shortages of qualified mathematics teachers. To help alleviate this problem, scholarships are available through the Department of Higher Education for teachers who are retraining to be mathematics teachers and for students majoring in mathematics and enrolled in a teacher education program.

Certification Requirements

All teaching certificates in Arkansas require at least nine semester hours in biological sciences, physical sciences and mathematics. Additionally, six semester hours of mathematics (designed for elementary teachers) and three semester hours of science (designed for elementary teachers) is required for the Six Year Elementary Certificate. Eighteen semester hours in either Middle School Science or Middle School Mathematics must be completed in addition to the requirements for either an Elementary Certificate or Secondary School Certificate in order to receive a Middle School Certificate. Secondary School Certificates require a specified number of semester hours in the area to be taught: mathematics - 21 semester hours, including 3 hours of calculus; general science - 24 semester hours; biological science - 24 semester hours; physical science - 24 semester hours; chemistry - 24 semester hours; and physics - 24 semester hours.

Alternative Certification

Provisional certificates may be issued to qualified candidates when a district is unable to employ a regularly certified teacher to fill a vacancy. Candidates must have at least a bachelor's degree in the appropriate subject area. Approximately 100 teachers per year take advantage of this certification route; however, fewer than 10 provisional certificates in mathematics have been issued since June, 1986.

A new one-year provisional certificate is available to teachers who move to Arkansas with active certification in another state.

Teacher Training

To upgrade the skills of science teachers, the State Department of Education works with state colleges and universities to offer additional science courses to teachers.

Mathematics specialists work closely with districts and with regional cooperatives to identify areas of need for teacher inservice programs. Specialists conduct training, or in some cases, arrange for training through external consultants. A recent regional meeting of the National Council of Teachers of Mathematics attracted approximately 1,400 elementary and secondary teachers of mathematics, most of which were from districts within the state. A similar meeting for science teachers is scheduled for the 1987-88 school year.

Staff Development Needs

The greatest staff development needs in the state are more courses for elementary teachers that match the Science Course Content Guides and courses that are designed for high school chemistry and physics teachers. The state also needs inservice for teachers of grades 4-8 in the content areas of geometry, probability and statistics.

FUNDING

Most of Title II funds in Arkansas provide inservice to teachers of science and mathematics in grades 4-6. A portion of the Chapter 2 funds are available for staff development based on school administrators' development of competitive grant applications.

RECENT STATE REFORMS/NEW INITIATIVES

The new state standards for school accreditation, adopted in 1983 and scheduled for full implementation by June 1, 1987, require that a great deal more science be taught at the elementary level. Also, science concepts will be tested on the state's Minimum Performance Test in grades 6 and 8. Both measures have promoted science instruction.

Mathematics education has also been promoted through the adoption of the new school accreditation standards. These standards increased the graduation requirements for students as well as the mathematics courses that must be provided by each district.

TRENDS AND ISSUES

Currently, the state is working to improve science education at the elementary level. The focus of their efforts will be junior high science in a few years.

The major problem in mathematics education is the lack of specific mathematics course work for certification at the elementary level. There are teachers who have very limited preparation in mathematics content. By providing inservice programs through the use of Title II and EICA Chapter 2 funds, many teachers are receiving appropriate staff development in mathematics. Teacher resource materials have been developed and are available for teacher use in content areas as determined by a statewide assessment.

CALIFORNIA

CURRICULUM

Curriculum Guides

The California Science Framework Addendum and the California Mathematics Framework were developed in 1984 and 1985, respectively, by committees appointed by the State Board of Education. The High School Model Curriculum Standards for all subject areas were also developed in 1985. State frameworks and curriculum standards serve as state recommendations to school districts.

New in 1987 are Elementary Model Curriculum Guides for grades K-8. The Curriculum Guides for Science were developed by a committee of teachers, science supervisors and university faculty. The Curriculum Guides for Mathematics were developed by a similar committee of mathematics educators. Use of the guides is not mandated; they contain recommendations for long-range staff development purposes rather than for daily lesson plans.

In sum, all these documents recommend rather than require curriculum. The framework addendum is for grades K-12 and is used for textbook adoption (K-8); the curriculum standards are for grades 9-12; and the curriculum guides are for grades K-8; all correlate with each other.

Higher Order Thinking Skills

Higher order thinking skills are one of California's main educational thrusts, especially the notion of teaching for understanding. The state's textbook adoption policies, the new K-8 curriculum guides and the Curriculum Implementation Centers (staff development by content area) all have this orientation.

Time Requirements

The state recommends that students in grades K-3 receive 100 minutes per week, and grades 4-6 receive 150 minutes per week of science and health instruction. It is also recommended that students in grades 7 and 8 study science for three of four semesters. For students in grades 9-12, a minimum of two years of science, including biological and physical science, is required by law.

Time allocations for mathematics instruction are recommended as follows: students in grades 1-3 receive 200 minutes per week of mathematics instruction, 250 minutes per week are recommended for grades 4-8, and two years are required for grades 9-12.

Graduation Requirements

Beginning with the class of 1987, all high school graduates in California must complete at least two years of science, including biological and physical science, and two years of mathematics. Additional graduation requirements may be developed by local school boards. No changes in these requirements are being proposed.

STUDENTS

Recognition and Awards

The state-sponsored Golden State Examination (GSE) was administered for the first time in spring 1987. The GSE was established by the Hughes-Hart Educational Reform of 1983 to identify and recognize honors-level achievement by students in specific academic subject areas. The 1987 GSE covered first-year algebra and geometry. Future tests will cover additional mathematics courses, laboratory sciences, U.S. history, English literature and composition, foreign languages and health sciences. Students will be recognized at one of three levels based on statewide standards: high honors, honors and school recognition. Students achieving high honors or honors will receive a certificate acknowledging their outstanding achievement, an insignia on their high school diplomas and a notation on their transcripts.

Summer Institutes, Magnet and Residential Schools

California's Senate Bill 813, signed into law in July 1983, targeted funds for the development of specialized high schools in high technology and the performing arts. Funds were first awarded in the fall of 1984. Currently, the state supports approximately 12 specialized high schools through Senate Bill 813 funds. The bill also provides some funding for summer schools in science, mathematics and other critical academic areas.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

The California Assessment Program of Science and Mathematics emphasizes higher order thinking skills, including those required to analyze complex relationships, draw inferences and reason deductively.

Assessment Content

California's assessment program is aligned with statewide curriculum objectives in both science and mathematics and is used to achieve state educational reform goals.

Assessment Reporting

Assessment results are reported for the state, districts and schools. These are also made public.

Test results are intended to provide schools with data on which to base improvement plans. Schools also use assessment results to emphasize their needs for special funds or for their participation in special programs.

State educational policy makers use test results to evaluate instructional programs and practices by making statewide and national comparisons. Policy makers also use assessment results to evaluate the effects of state and federal programs, to distribute funds according to need and to identify potential exemplary programs or practices.

Subject Areas Assessed

In 1987, every student in grades 3, 6, 8 and 12 has been tested in mathematics, reading and language arts. In addition, students in grade 8 have been tested in writing (essay), history/social science and science. In 1988, the writing (essay) component will be administered to 10th, 11th or 12th grade students. The next change in the California Assessment Program will occur in 1990 (if the Governor's budget is approved) when science and history/social science testing will be added at grades 6 and 12.

TEACHERS

Teacher Recruitment and Retention

California uses a small forgivable loan program as a recruiting tool available for people who want to teach in one of the shortage areas: science, mathematics, bilingual education and special education. A maximum of 500 teachers compete for $2,000 loans that they may receive for up to three years. One year of the loan is forgiven for each year of teaching.

Another measure California has taken to recruit and retain teachers is raising beginning teachers' salaries.

Teacher Shortages

California is experiencing teacher shortages in science and mathematics. The Los Angeles Unified District has a critical shortage of mathematics teachers at the high school level. The state is addressing these shortages in several ways, one of which is the student loan forgiveness program.

California, in conjunction with the German Federal Republic, participates in a program that recruits science, mathematics and other teachers from Germany. This program also serves as a cultural exchange program.

In addition, Bill Honig, California's Superintendent of Public Instruction, and Ann Reynolds, the head of the California State University System, launched a teacher recruitment and public awareness campaign in April 1986. Honig has visited university campuses with teacher-credentialing programs. Pamphlets that explain the rewards of teaching, provide general information about the profession and carry the campaigns slogan, "A Class Act: Be a Teacher," have been widely distributed.

Certification Requirements

To teach in any self-contained classroom or in departmentalized classes below grade 9, a teacher must be authorized for multiple subject instruction and have a minimum of eight semester hours in the subjects to be taught. To be authorized for single subject instruction, a teacher must have at least a bachelor's degree in the subject to be taught. A fifth year of professional study must be completed for credentialing. The credentialing requirements are currently under review and modifications are likely to occur in the next few years.

Alternative Certification

Emergency credentials may be issued when there is a verified shortage of regularly certified teachers. In 1985-86, 464 emergency credentials were issued.

The Teacher Trainee Program is another alternate certification route. Applicants must have a bachelor's degree in the subject area to be taught. Regular certification may be granted after two years of successful teaching with a mentor teacher.

The Los Angeles Unified District has the majority of teachers who have taken advantage of these certification options.

Teacher Training

Many efforts are being made to upgrade the skills of science and mathematics teachers. Training is provided to science teachers by universities and professional organizations on laboratory safety, effectively using science test results and using technology in the classroom.

The California Mathematics Project is the primary project designed to improve the teaching skills of mathematics teachers. Each year $1.2 million is allocated by the legislature for the project. The money is dispersed to 16 college campuses within the state where over 400 teachers receive inservice training in mathematics.

The state education agency sponsors Curriculum Implementation Centers for science and mathematics. The Curriculum Implementation Centers focus on how to transform an entire school mathematics program. One to two teachers from schools around the state receive direct training and information at a center that they then disseminate to their colleagues.

Staff Development Needs

Staff development needs among elementary mathematics teachers include more experience with student experiments, working with materials and receiving more ongoing support and advice.

At the secondary level, cross-over teachers (teachers who are credentialed in a subject area other than the one they are teaching) who lack basic mathematics skills need customized inservice in general mathematics. Credentialed mathematics teachers need to learn about and utilize new teaching techniques rather than to rely on lecturing.

FUNDING

Districts are using Title II funds for science and mathematics training workshops, staff travel expenses to conferences and instructional materials.

RECENT STATE REFORMS/NEW INITIATIVES

California continues into the fifth year of a broad reform effort that stresses the alignment of instructional materials, testing and staff development with the desired curriculum that is now fairly well defined.

TRENDS AND ISSUES

To improve science instruction in the state, policy makers are trying to create the reforms necessary to enable students to grasp fully science concepts and their societal implications. They are also trying to confront the demands presented by large class sizes with the need for hands-on participatory science learning. Furthermore, they are trying to promote opportunities in science for women and minorities.

The biggest barriers the state faces in improving mathematics instruction include the lack of commitment to professional development, the lack of suitable instructional materials (textbooks still don't match the desired curriculum), the rigid devotion to commercial, standardized tests and SAT scores (which distract from the really important matters of teaching) and parents and administrators' lack of appreciation of the benefits of an ideal mathematics curriculum.

The state is working on obtaining suitable instructional materials and creating ways to assess students' understanding. Work is also under way to change the way administrators view mathematics curriculum. The biggest challenge lies in reaching parents; the state needs the help of the media to achieve this goal.

COLORADO

CURRICULUM

Curriculum Guides

The State Science Curriculum Workbook and the State Mathematics Curriculum Workbook that list recommended learner outcomes and skill competencies are available to be used as the basis for modifying graduation requirements, curriculum, and teacher preparation and certification requirements. The State Science Task Force and the State Mathematics Task Force committees, appointed by the Colorado Board of Education composed of representatives from K-12 public schools and state teacher education programs, developed the workbooks in 1984. Neither have been revised. However, two follow-up reports, one containing recommendations for revising the geometry curriculum and one for continuing education, were completed in the 1985-86 school year.

Higher Order Thinking Skills

The state science and mathematics task forces' recommendations and curriculum workbooks emphasize science and mathematics processes, critical thinking and problem solving. Teaching higher order thinking skills is a major focus of the inservices presented by the state science and mathematics consultants.

Time Requirements

The Colorado Science Task Force has also made recommendations concerning the amount of time devoted to science instruction. Two hundred minutes per week for grades 5 and 6 and 225 minutes per week for grades 7-9 have been suggested.

Graduation Requirements

Local school boards determine their own graduation requirements because Colorado's constitution prohibits the state from doing so.

STUDENTS

Recognition and Awards

Colorado students in grades 10-12 and especially interested in science may participate in the U.S. Department of Energy High School Student Honors Summer Institutes. Exceptional students in grade 12 may attend the National Youth Science Camp, sponsored and funded by the state of West Virginia, National Science Educators and business and industry.

Talented mathematics students in grades 7 and 8 may take part in Math Counts, a National Council of Teachers of Mathematics' sponsored contest. State-level winners participate in a national-level competition. The Colorado Council of Teachers of Mathematics provides teachers with certificates of recognition to be given to their students. Individual students and teams of students in grades 10-12 may compete in the C.S.U. Math Day held at the Colorado State University campus. The U.S.C. (University of Southern Colorado) Math Day is another contest similar to the C.S.U. Math Day in which 10th through 12th grade students may participate.

Summer Institutes, Magnet and Residential Schools

The state education agency does not support magnet schools or special summer institutes. However, some summer institutes are supported by various state universities. For example, the Frontiers of Science, an ongoing summer program offered to juniors and seniors, is sponsored by the University of Northern Colorado. Gifted and talented students' programs and other special programs are typically developed at the local level.

Special Populations

Participation of underrepresented groups in science education is stimulated through the MESA (Minority Engineers and Scientists Association) program in Colorado. Minority groups in grades 7 through 12 are encouraged to develop strong backgrounds in science and mathematics to pursue related careers. Through Colorado's Educational Reform Act 2 + 2 Project the commitment has been renewed to build school experiences that ensure these students are intellectually nourished. Expanding Your Horizons in Science and Mathematics conferences for female students in grades 7 through 9 make girls aware of career opportunities in technical fields such as engineering and computer science. At least 30% of Title II funds target special populations. These monies are managed by the Colorado Department of Education.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

Colorado piloted in 1986-87 a variety of instruments that include higher order thinking skills in volunteer districts. The state is also working with McRel to develop a measure for 1987-88.

Assessment Content

Assessment content is not coordinated with state curriculum guides because no curriculum guides or objectives, per se, exist for Colorado.

Assessment Reporting

Assessment results are reported for students, districts and the state. Student results are never made public under the Colorado "Open Records" Laws; school results are made public if ordered by their district. The Colorado "Open Records" Laws require that district results are made public if all students within the district are tested. State results are always made public.

Schools use assessment results to determine student achievement level. Districts and state educational policy makers use assessment results to identify the strengths and weaknesses of curricula. In addition, policy makers use assessment results to allocate resources for technical assistance and to examine the effectiveness of local control.

Subject Areas Assessed

In 1987, a sample of students in grades 3, 6, 9 and 11 are being tested in writing, readiness, ability/achievement (includes reading, language arts, mathematics, science, social studies and reference skills) and health and physical fitness.

TEACHERS

Teacher Recruitment and Retention

Colorado's 2 + 2 Project is examining ways to provide career development opportunities and to reward teaching excellence. The 2 + 2 Project is also investigating ways in which school districts can offer the pay, recognition, respect and career advancement necessary to attract and retain qualified teachers.

Teacher Shortages

Colorado is experiencing minor teacher shortages in rural areas of the state, and a more widespread shortage is predicted for the future.

The Colorado 2 + 2 Project, in addition to examining ways to attract and retain teachers, is also studying provisional certification alternatives, an intern/residency program and state standards for college-level preparation.

Certification Requirements

Within the liberal arts preparation of preservice elementary education, some course work in science and mathematics is required. A science methods course and a mathematics methods course is also required. The state of Colorado does not require a specific number of hours in science or mathematics.

A Middle School Certificate (grades 5-9) is available in which the applicant can complete a major in mathematics with a supporting field or major academic preparation in two related fields or a focus on a broad interdisciplinary field.

Secondary certification in science or mathematics requires a science or mathematics major as specified in the state certification guidelines.

Colorado does not have a requirement for a fifth year of professional education to become certified.

Alternative Certification

Colorado issues emergency letters of authorization, valid for one year and renewable, to qualified persons if the State Board of Education determines that an emergency situation exists due to a shortage of regularly certified teachers. For the 1986-87 school year, 18 individuals had current emergency letters of authorization in science and 18 additional individuals had current emergency letters of authorization in mathematics.

Teacher Training

A science consultant and a mathematics consultant have been employed by the Colorado Department of Education since the fall of 1984. The consultants' primary focus has been on training teachers in current science and mathematics teaching techniques, including science processes, reasoning development, problem solving and the use of manipulative materials at all grade levels. In addition, most of the Title II monies have been used for teacher inservice training.

Staff Development Needs

The greatest staff development need among science teachers is incorporating science process instruction and more laboratory instruction into the science curriculum at all grade levels.

Mathematics teachers need training in incorporating the use of hands-on manipulative materials into the mathematics curriculum at all grade levels. They also need training in the "true" meaning of problem solving and how to integrate problem solving into their mathematics programs.

FUNDING

Districts are using Title II funds primarily to provide inservice for teachers to update methods of teaching science and mathematics, science processes, problem solving and critical thinking skills in particular. In addition, districts have used funds to purchase science hands-on materials and mathematics manipulative materials to be used at all grade levels, especially the elementary level (K-6).

RECENT STATE REFORMS/NEW INITIATIVES

There have been no recent state reforms that have affected either science or mathematics instruction. However, the Colorado 2 + 2 Project is examining ways to provide career development opportunities for teachers in all subject areas.

TRENDS AND ISSUES

The three biggest problems Colorado faces in improving science and mathematics instruction are the following:

1. Providing continuing funds to support full-time science and mathematics consultants;
2. Providing college science and mathematics courses for teachers at all levels. Courses need to be offered within the rural B.O.C.E.S. areas — a major obstacle is providing funding for instructors for these courses; and
3. Organizing and coordinating science educators to provide workshops and seminars for teachers on a statewide basis.

CONNECTICUT

CURRICULUM

Curriculum Guides

Connecticut's Guide to Curriculum Development in Science, developed by the state education agency and the Science Teachers Association, is currently being revised (1987). The guide includes recommended objectives for grades 4, 8 and 12 plus curriculum recommendations for all grades, K-12.

In 1986, A Guide to Curriculum Development in Applied Mathematics: A Three-Year Sequence for Non-College Bound Students was developed by the Project to Increase Mastery of Mathematics and Science (PIMMS) and the Connecticut State Department of Education. The curriculum guide includes objectives in mathematics for grades 9-12.

New this year, 1987, is Connecticut's Common Core of Learning. Developed by an advisory committee to the State Board of Education, the common core contains recommended "outcomes that should result from the entire K-12 school experience, including academic skills and knowledge, personal and social skills, attitudes and attributes." Furthermore, the common core is intended to be "an integrated and interdependent set of learning outcomes, "not a set of isolated competencies." (Connecticut's Common Core of Learning, Connecticut State Board of Education, Hartford, Connecticut, January 7, 1987.) Science and technology and mathematics are included.

The Connecticut Mastery Testing Program, developed by an advisory committee for grades 4, 6 and 8, outlines recommended mathematics objectives to be tested. Although the objectives are officially recommended (de jure), they become required (de facto) in the classroom.

Higher Order Thinking Skills

Higher order thinking skills are emphasized in both science and mathematics through problem solving, microcomputer based laboratories and technology. Additionally, summer institutes and the mastery test objectives focus on these issues.

Time Requirements

The state's schools follow recommendations of the Science Advisory Committee regarding the amount of time that should be spent on science instruction. The suggested time allotment for grades 1-4 is 75-150 minutes per week, 135-200 minutes per week for grade 5, 250-300 minutes per week for grades 6-8 and 280 minutes per week for grades 9-12.

Recommended time allotments also exist for mathematics. The state suggests that 225 minutes per week be spent on mathematics instruction in grades 1-3, 300 minutes per week in grades 4-6 and one period per day in grades 7-12.

Graduation Requirements

Prior to 1983 graduation requirements were at the discretion of local districts. The legislature passed a requirement of 18 total units effective for the graduating class of

1987. For the graduating classes of 1988 onward, 20 total units are required: two units of science and three units of mathematics.

STUDENTS

Recognition and Awards

There are several recognition programs in science and mathematics at the local, regional, state and national levels in which students may participate. Such programs include the Junior Science and Humanities Symposium for grades 10-12, sponsored by private organizations, local industry, the state education agency and the United States Army; the Connecticut Science Fair for grades 7-12, sponsored by districts and industry; the Invention Fair for elementary and middle school students, sponsored by districts and state colleges; and Science Olympiads for high school students, sponsored locally with support from industry and assistance from the State Department of Education. Other recognition programs in science include the West Virginia National Youth Science Camp and the Department of Energy programs.

Summer Institutes, Magnet and Residential Schools

The state indirectly supports magnet schools for students in grades K-12 studying science and mathematics. The state accomplishes this by allocating funds to districts that in turn support magnet schools. These types of special schools are located in localities throughout the state, including Hartford, Bridgeport and New Haven.

In the same fashion described above, the state indirectly supports the Connecticut Scholars' Program, a four-week summer program for secondary level students. Advanced courses in all basic subject areas, including science and mathematics, are offered. Approximately 100 students participate each summer.

Special Populations

Connecticut actively seeks the involvement of underserved groups in special science and mathematics programs. For instance, for gifted students there are 140 special programs that cover all subject areas and are state and locally supported. The state also supports the PIMMS Multiply Your Options conferences that provide female role models in science and mathematics for high school girls. The Connecticut Science Museum, the University of Connecticut, Trinity College and the Department of Higher Education support a program that encourages minorities to go into science-related fields. Additionally, the state participates in the EQUALS program and family mathematics workshops.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

The state includes problem-solving items, direct performance items (i.e., writing samples, scientific experiments, note taking, etc.) and evaluation and inferential items in its assessment program.

Assessment Content

The content for Connecticut's Mastery Test (CMT) is determined by committees of experts who are knowledgeable about local curriculum objectives and state goals for the subject area.

Assessment Reporting

The Connecticut Assessment of Educational Progress (CAEP) assessment results are reported for the state only. If the school district participated in local option (piggyback), results are available.

The CMT assessment results are reported for the state, districts, schools and students. State and district results are made public; school results are available through the local school district if requested. Student results are available to classroom teachers.

The results of Connecticut's Mastery Test are used to evaluate individual performance in language arts/reading and mathematics, the effectiveness of instructional programs in language arts/reading and mathematics and the effectiveness of the remedial assistance programs in language arts/reading and mathematics. Results from the mastery test may not be used as the sole criterion for promotion or graduation.

Subject Areas Assessed

From 1987 through 1990, every student in grade 4, 6 and 8 will be administered Connecticut's Mastery Test that will cover reading, language arts, writing and mathematics.

TEACHERS

Teacher Recruitment and Retention

Included in the Education Enhancement Act of 1986 was a minimum salary law that may serve to attract and retain teachers. The state also has a loan program for teachers of physics and mathematics, which the teachers repay after they begin teaching. Districts are also actively involved in teacher recruitment.

Teacher Shortages

Connecticut has a shortage of qualified science teachers; however, the problem is not as bad as it has been in the past. Higher teacher salaries, the teacher loan program and continued staff development are some of the methods the state has used to partially alleviate the problem.

There is no reported shortage of mathematics teachers.

Certification Requirements

Three semester hours in both science and mathematics is required for elementary certification. For secondary certification in biology, chemistry, physics and earth science, 18 semester hours are required in the specific subject area. Secondary certification in general science requires 21 semester hours, including course work in biology, chemistry, physics and earth science. Secondary certification in mathematics

also requires 18 semester hours of course work. Middle school/junior high school certification is not available in Connecticut. By 1992, an academic major in an appropriate subject will be required for secondary certification in science and mathematics.

Alternative Certification

Ninety-day certificates are available to people holding bachelor's degrees but who lack the necessary course work in teacher education. Additional requirements include passing a basic skills and subject area test and participation in a four- to six-week teacher preparation course. At the end of the 90-day period, the candidate is evaluated and upon approval issued an initial certificate. Approximately five persons per year become certified to teach mathematics through this alternate route.

Teacher Training

To upgrade the skills of science and mathematics teachers, the state offers an extensive range of summer institutes and ongoing professional development opportunities. For example, 19 science inservice workshops are scheduled for the summer of 1987. There is also an array of recent proposals designed to upgrade the skills of current teachers that range from increasing teacher certification requirements to requiring teacher testing and assessment.

Staff Development Needs

The greatest staff development needs among science teachers include bringing them up-to-date with new technologies and modern developments in particular subject areas and increasing their abilities to communicate among themselves.

Mathematics teachers need to learn more effective instructional techniques, including the incorporation of materials and technologies into the instructional program.

FUNDING

Districts use their Title II funds in varied ways but most often to provide professional development at the school and district levels and to underwrite conference expenses. These funds are also being used for curriculum development.

RECENT STATE REFORMS/NEW INITIATIVES

The Education Enhancement Act has promoted both science and mathematics instruction by upgrading teacher preparation guidelines, increasing certification requirements, increasing monies available for staff development and increasing teacher salaries.

The Connecticut Master Testing Program has improved mathematics instruction by putting more emphasis on mathematical concepts and problem solving.

TRENDS AND ISSUES

A great deal of attention is being paid to elementary science instruction revision in Connecticut; although science is not classified as one of the basic skills at this level.

Elementary science instruction lacks general support for revision and hands-on experience for students, plus there is not adequate equipment. The lack of adequate equipment is especially a problem in poorer, rural districts. Staff development in science is another problem area, and a specific need is to increase the use of new technologies.

Physical science, particularly laboratory safety, at the elementary and middle school levels has recently received attention from state policy makers and the public. In science curriculum, prevalent societal issues, such as the implications of hazardous wastes and acid rain, have also recently received attention at the state level.

Problems that the state faces in improving mathematics instruction include upgrading the overall quality and responsiveness of the mathematics curriculum, K-12, upgrading teacher training and retraining and encouraging the consistent use of materials and technology.

DELAWARE

CURRICULUM

Curriculum Guides

Delaware has Standards of Performance for both science and mathematics that contain recommended course content. These standards were developed by the state education agency in cooperation with local education agencies, state advisory committees and teachers. The standards related to science were last revised in 1987 for grades 3, 6, 8 and 9-12; the standards related to mathematics were last revised in 1986 for grades 3, 6, 8 and 9-12.

Higher Order Thinking Skills

The Standards of Performance for both science and mathematics emphasize the teaching of higher order thinking skills, especially problem solving and applications. The state is currently planning to develop a proposal that would further emphasize higher order thinking skills in all areas of the curriculum.

Time Requirements

The state recommends that students in grades 7-12 receive 225-300 minutes per week of science instruction. Time recommendations relating to mathematics instruction are as follows:

- Grades 1-3 — 225 minutes per week
- Grades 4-6 — 250 minutes per week
- Grades 7-12 — 225-300 minutes per week

Graduation Requirements

In Delaware, beginning with the class of 1987, all students are required to complete two credits of science and two credits of mathematics. Local districts are encouraged to implement course and credit requirements beyond the state minimums.

STUDENTS

Recognition and Awards

The state education agency and others sponsor the Science and Humanities Symposium and the Science Olympiad. Both programs offer outstanding science students an opportunity to participate in extracurricular activities relating to science during which they receive recognition for their academic achievements.

Several recognition programs exist for outstanding mathematics students that are sponsored by the State Department of Education, the Delaware Council of Teachers of Mathematics, Johns Hopkins University and professional engineers. These programs include but are not limited to the State Secondary Math League (grades 7-12), the State

Elementary Math League (grades 4-6), Math Counts (grades 7 and 8), High School Math Exam/Junior High Math Exam, Computer Fair (grades 1-12) and the CTY Talent Search (grade 7).

Summer Institutes, Magnet and Residential Schools

In the past four years, Delaware's state education agency and duPont Corporation's Committee on Educational Aid have sponsored three-week summer institutes in mathematics, verbal skills and computer programming for outstanding 7th grade students who qualify in the Johns Hopkins Talent Search. Parents pay part of the cost for the program, which includes an opportunity for students to use computers.

The Governor's School for Excellence, a one-week residential summer program at the University of Delaware, is designed to recognize outstanding students in both public and private schools who have completed 10th grade. Participants are chosen on the basis of academic achievement and leadership abilities.

The Advanced Studies Program, a six-week residential program at the University of Delaware, is sponsored by the State Department of Public Instruction and the University of Delaware. The program is open to juniors in public, private and parochial high schools.

Special Populations

The Summer Science Leadership Conferences, sponsored by the Department of Education, are programs that encourage women to pursue science careers. FAME, a project sponsored by duPont, provides support for minority students who intend to study engineering at the university level. The Comets Program, for women and minorities, includes career-oriented modules to enrich topics in science.

During the school year there are programs in mathematics for special populations in the New Castle County area. In Sussex County a mathematics/verbal program for gifted students is held.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

In addition to content classifications of items in the California Test of Basic Skills, the publisher also provides a process classification that describes the way a student deals with the concepts and principles implicit in the items. This process approach is derived in part from Bloom's Taxonomy. The four process categories used in classifying CTBS items are recall, translation of explicit information, inferential reasoning and evaluation.

Assessment Content

The Delaware Educational Assessment Program was shaped by 1978 legislation that provided for the implementation of a statewide achievement testing program. This legislation provided that statewide standardized testing be mandated for grades 1-8 and 11 in the content areas of reading, English and mathematics. To expand beyond this "basic skills" testing, the battery of tests given to 11th grade students includes science and social studies.

Assessment Reporting

Assessment results are reported for the state, districts, schools and students. Results for the state, districts and schools are made public.

Delaware's schools use assessment results to: (1) diagnose individual pupil strengths and weaknesses, (2) place students in instructional groups or programs, (3) guide and counsel students, (4) identify instructional weaknesses and (5) aid in instructional planning.

Districts use assessment results to: (1) monitor year-to-year achievement progress in each of the content areas in each of the grades tested, (2) identify and remedy curricular weaknesses and (3) aid in local decision making relating to educational programs and policies.

State education policy makers use assessment results to: (1) monitor year-to-year achievement progress in each of the content areas in each of the grades tested, (2) identify and remedy curricular weaknesses and (3) aid in decision making at the state level relating to educational programs and policies.

Subject Areas Assessed

Every student in grades 1-8 and 11 is annually tested in reading, English and mathematics. Students in grade 11 are also tested in science and social studies.

TEACHERS

Teacher Recruitment and Retention

A program was initiated in 1985 that makes available interest-free student loans to undergraduates receiving teacher training in a critical shortage area designated by the State Board of Education. The loans are forgivable if the student goes on to teach in the critical shortage area for a minimum of two years in a Delaware public school.

Teacher Shortages

The state of Delaware currently has teacher shortages in the physical sciences and mathematics. Critical curricular areas, including those listed here, are identified annually. The State Board of Education and the State Department of Public Instruction recommend a budget to the legislature in support of recruiting and retraining teachers in the identified critical areas.

Certification Requirements

Delaware has three types of certificates: Early Childhood, Elementary and Secondary. Three semester hours of mathematics are required for Early Childhood and Elementary certification. Secondary certification requires a bachelor's degree and 15 semester hours of professional education course work. Additional course work requirements, in semester hours are for teachers of chemistry 42; physics - 45; biology - 39; earth science - 39; and general science - 36. Thirty semester hours are required in the specific teaching field of mathematics. (The amount of course work required in science for Early Childhood and Elementary certification was not reported.)

Alternative Certification

Limited standard certificates are available to people with a bachelor's degree in a critical shortage area (mathematics, physics, chemistry and computer science) who have not completed a teacher education program. The requirements necessary to become fully certified must be completed within three years. To date, there are 184 persons enrolled in this program.

Teacher Training

To upgrade the skills of science and mathematics teachers, the state offers inservice programs through Title II Education for Economic Security Act and Math Education Funds at the state level.

Staff Development Needs

Science teachers in all grade levels need to increase their science content knowledge. Mathematics teachers (grades K-6) need to become more familiar and comfortable with the use of manipulatives, technologies and problem solving. Secondary mathematics teachers need more training in the areas of problem solving and the use of technologies.

FUNDING

Districts use Title II funds to provide inservice workshops and conferences.

RECENT STATE REFORMS/NEW INITIATIVES

The new two-year science and mathematics credits that are required for high school graduation have promoted both curricular areas by increasing enrollment in science and mathematics courses.

TRENDS AND ISSUES

The three biggest problems Delaware faces in improving science instruction are:

1. Creating a pool of individuals to fill the openings in physical science;
2. Providing guidance to teachers who are teaching the "slower classes"; and
3. Upgrading science laboratory skills.

The three biggest problems the state faces in improving mathematics instruction are:

1. Implementing manipulatives in grades K-6;
2. Emphasizing the role of the calculator and computer in grades 7-12; and
3. Improving the high school mathematics program.

DISTRICT OF COLUMBIA

The District of Columbia did not provide answers to the specific survey questions related to mathematics.

CURRICULUM

Curriculum Guides

The District of Columbia has developed curriculum guides for grades K-12, including science guides for grades K-6 and 7-9 in biology, chemistry, physics, science and social issues and lab skills. Scope and sequence documents have been developed for other science courses. Districts are required to use the guides, each of which includes performance objectives, instructional activities and assessment tasks. The guides were developed by committees of teacher-writers and revision is continual (current work is on elementary science and physics; chemistry and biology were completed last year). Similar guides have been developed for the mathematics curriculum.

Higher Order Thinking Skills

The required curriculum guides, at all levels, include open-ended activities and problem solving.

Time Requirements

The state recommends that students in grades 1-3 receive 90 minutes per week of science instruction and 135 minutes per week in grades 4-6; 250 minutes per week in grades 7-9 are recommended.

Graduation Requirements

Two units of science are required for high school graduation.

STUDENTS

Recognition and Awards

Recognition programs for students in science include the District of Columbia Annual Science Fair, the SHARP Program at the Goddard Space Flight Center (eight weeks of work with a scientist at minimum wage) and opportunities for students to work for the Department of Defense at George Washington University, Fermi Laboratory, Berkeley, Livermore and Stony Brook.

Summer Institutes, Magnet and Residential Schools

No state-supported summer or magnet programs were reported.

Special Populations

The Math, Science and Minorities K-6 program is sponsored by the Mid-Atlantic Center for Race Equity. In addition all of the District of Columbia's programs are really for minorities because the district is 96% black, 3% other than white and 1% white.

STUDENT ASSESSMENT

No information was received on student assessment.

TEACHERS

Teacher Recruitment and Retention

Teachers may write proposals to obtain grants up to $5,000 to initiate programs.

Teacher Shortages

No current teacher shortages were reported in science.

Certification Requirements

The Elementary School (1-6) Certificate requires six semester credits in science and nine semester credits in mathematics. The Secondary School (7-12) Certificate requires 30 semester hours in the subject to be taught (including science and mathematics). A teacher-mentor program guides and nurtures new teachers.

Teachers must earn six credits every five years to maintain their certification.

Alternative Certification

No alternative certification program was reported.

Teacher Training

The District of Columbia offers inservice programs in both science and mathematics to upgrade the skills of teachers. In addition, a teacher-mentor program is sponsored for teachers new to the district.

Staff Development Needs

The greatest staff development need among science teachers is to get elementary science teachers to take science courses and methodology courses.

FUNDING

The District of Columbia uses Title II funds to establish and operate a Math/Science Center that offers materials on loan, inservice courses and laboratory facilities. "Regular budget" money is being used to renovate laboratory rooms in nine junior high schools and five senior high schools.

RECENT STATE REFORMS/NEW INITIATIVES

A new testing program in each K-10 science course, using criterion-referenced tests, is in place. Grades 11-12 will be added next year.

TRENDS AND ISSUES

The three biggest problems the District of Columbia faces in improving science instruction are:

1. Keeping schools supplied with materials;
2. Minimizing interruptions in regular classes caused by special activities; and
3. Trying to prevent teachers from other fields from being assigned to teach science.

FLORIDA

CURRICULUM

Curriculum Guides

Pursuant to Chapter 233.011, Florida Statutes, and Chapter 83-350, Laws of Florida, the state of Florida requires use of curriculum frameworks for the purpose of ensuring instructional consistency and assessment within academic disciplines among public high schools. In addition, student outcomes specified in each curriculum framework are used to develop uniform statewide student performance standards and assessment instruments.

Curriculum frameworks are used in science courses at grades 9-12 and grades 6-8. A curriculum framework is a set of broad guidelines that aid educational personnel in producing specific instructional plans for a given subject area or area of study. Since there are 44 approved 9-12 science courses (Biology I, Chemistry I Honors, etc.), there are 44 curriculum frameworks. In grades 6-8, 21 courses (Middle/Junior High Life Science Basics, Middle/Junior High General Science Advanced, etc.) and curriculum frameworks exist. Statewide writing teams staffed by Department of Education consultants, school district staff and university personnel developed these frameworks. In addition, frameworks were reviewed by all 67 school districts (counties) and recommendations were incorporated into the final product. The frameworks are required for use in all grades 6-8 and 9-12 science courses (all schools and all districts). Curriculum frameworks (9-12) for all science courses were initiated in August 1983, State Board of Education approved in January 1985 and required for use beginning with the 1985-86 school year. Course performance standards (grades 9-12) and curriculum frameworks (grades 6-8) for selected science courses were initiated March 1985, State Board adopted March 1986 and required for use beginning with the 1986-87 school year. All districts may participate in an annual revision process to submit new courses and new curriculum frameworks.

Curriculum frameworks and student performance standards also exist for selected mathematics courses (grades 9-12) and (grades 6-8). The use of these frameworks is also required by districts.

Higher Order Thinking Skills

In science, both Minimum Student Performance Standards (alias: functional literacy test) and Student Performance Standards of Excellence address both process skills as tools for science investigation and problem-solving skills in science. Instruction in these areas is required by law in all grade levels and special skills are assessed in grades 3, 5, 8 and 11.

Problem-solving skills are also included in all of the mathematics curriculum frameworks and guidelines.

Time Requirements

For grades 4 and 5, Florida Statute 230.2319 provides for the regularly scheduled study of science, but it leaves the definition of "regularly scheduled" up to the districts. For grades 6, 7 and 8, 225 - 300 minutes per week for three years are required for science instruction.

There are no specific time requirements in mathematics in Florida statutes. However, some of the largest counties with the largest populations adopt minimal instructional time requirements.

Graduation Requirements

Beginning in the 1984-85 school year, students in grades 9-12 need three credits in science (two with a laboratory component) and three credits in mathematics for high school graduation in Florida. The State Board of Education established minimum performance standards in the areas of reading, writing, mathematics, science and computer literacy. A functional literacy exam designed to measure application of these basic skills to everyday life is given to all 11th graders. Students must pass this exam to receive a regular high school diploma. In addition, a GPA of 1.5 on a 4.0 scale is needed in all required courses effective with the 1986-87 school year.

A bill proposed to the Florida legislature in spring 1986 to reduce the number of science credits required for graduation from three to two and mathematics credits from three to two was defeated.

STUDENTS

Recognition and Awards

The Florida Foundation for Future Scientists, supported financially in part by the state legislature, administers the State Science and Engineering Fair (grades 6-8 and 9-12), the Junior and Senior Outstanding Narrative Colloquium, (J.A.S.O.N., grades 11 and 12) and the Junior Science, Engineering and Humanities Symposium (J.S.E.H.S., grades 9-12). In addition, the state of Florida also rewards outstanding performance and academic achievement to high school students by awarding a special certificate designating the graduate as a Florida Academic Scholar. The program, based on requirements of advanced-level courses, additional credit requirements, and high scores on the ACT or SAT tests, qualify the candidate for automatic admission to state universities or state colleges within Florida. Students are awarded scholarships from the Florida Undergraduate Scholars Fund, and these scholarships are renewable each year for qualified candidates. The PRIDE program, a Program to Recognized Initiative and Distinction in Education, sponsored by the Commissioner of Education, identifies outstanding students in the areas of science and mathematics through a series of school, district, regional and state competitions. Scholarships and awards are also given. Florida students also compete in various school, district, state and national programs of competition. These include but are not limited to: Thomas Edison/McGraw Scholarship Program (9-12), Annual Photography Contest, Science American Association for Advancement of Science, The Great International Paper Airplane Contest (14 years and younger), International Science and Engineering Fair (9-12), Duracell Scholarship Competition (9-12), Junior Engineering Technical Society (JETS, 9-12), Science Challenge Award (7-12), DISCOVER Science Scholarship (12th), Westinghouse Science Talent Search (12th), NASA Space Shuttle Involvement Program (N.S.S.I.P. "Launch and Land," 7-12), Phillips Petroleum Company - Student Search for Solutions (7-12), Tests of Engineering Aptitudes, Math and Science for Minorities (T.E.A.M.S., 9-12), Student Expeditions on Engineering Resources (S.E.E.R., 11-12), National Student Science Competition (NSSC, 7-12), Science Olympiad (7-12), West Virginia National Youth Science Camp (12th), Junior Academy of Science Competition (6-12), Florida Chemathon (9-12), Physics Olympics (11-12), Math Counts, American High School Mathematics Education Contest (AHSME)

and the Florida Mathematics Council award prizes to mathematics students for outstanding achievement (finalists qualify for the International Olympiad (10-12).

Summer Institutes, Magnet and Residential Schools

Recent legislation allows Florida's state education agency to award grants ($1,213,465 for 1986-1987) to public school districts, higher education institutions and science museums and centers to conduct summer camps for students in mathematics, science or computers. Nonprofit organizations or any educationally oriented organization may also apply for these grants.

Special Populations

The Florida Endowment Fund for Higher Education is striving to "enhance equality in providing access to effective higher education programs for minority and economically deprived individuals in Florida with particular consideration to be given to the needs of both blacks and women; and to increase the representation of minorities . . . in higher education."

The College Reach Out Program was allotted $370,000.00 to strengthen the educational motivation and preparation of low income or educationally disadvantaged high school students (including $25,000 for the Florida Indian Youth Summer Program sponsored by the Governor's Council on Indian Affairs).

Other programs:

Challenge Grant for the Gifted	$ 509,538
Miccosukee Indian Education Program	$ 64,522
Seminole Indian Education Program	$ 65,910
Telecommunications Devices for the Deaf	$ 550,000
Black Doctorate Fellowship Program (falls under Postsecondary Monies)	$ 500,000
Migrant Education (3 and 4 years)	$ 2,299,810
Preschool Project	$ 500,000
State Compensatory Education	$38,348,287
Profoundly Handicapped Program Adjustment	$ 3,005,331

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

The state of Florida did not report addressing higher order thinking skills in its assessment program.

Assessment Content

The standards and skills that are assessed in Florida's census testing program were developed by curriculum experts from the Department of Education and districts in committee meetings with teachers, parents and citizens of the state. The standards and skills have been disseminated throughout the state.

In addition to the state assessment item bank, separate item banks were developed for districts which include certification standards and skill remediation.

Assessment Reporting

Assessment results are reported for the state, districts, schools and students. Assessment results for FE/C/EE (items sampling/pupil sample) are reported as state-level results only. Results for the state, districts and schools are made public. Students are given results; parents have access to student records.

Florida schools use students' SAT results to identify, for remediation purposes, individual student weaknesses in the basic skill areas. School level results are used as a basis for developing programs and strategies that meet student needs. School and district results are used to evaluate instructional programs. School composite scores are viewed as an index of student achievement on Minimum Student Performance Standards.

State education policy makers use state results to assure the public that, at a minimum, all Florida students will achieve basic education skills. Schools with composite scores below 80% are identified by the state. Distribution of funding for remedial education is linked to assessment results.

Subject Areas Assessed

In 1987, all students in grades 3, 5, 8 and 10 are tested for mathematics, reading and writing skills. This state-developed test is revised annually. Science assessment questions are currently under development and testing will begin no earlier than the fall of 1989.

TEACHERS

Teacher Recruitment and Retention

The Department of Education Center for Career Development Services has initiated an in-state telephone number (1-800-Teach- FL) and an out-of-state telephone number (1-800-FL-Teach) to assist in the area of teacher recruitment referrals. In addition, the department sponsors the Great Florida Teach-In, a teacher job fair, each June. Of the 1,500 teachers who attended the 1986 teach-in, over half were offered a contract to teach in Florida. Furthermore, $9.4 million was appropriated in 1984 for the funding of summer training programs.

Teacher Shortages

Science is identified as a "critical teacher shortage area" under section 231.62, Florida Statutes. However, it is predicted by the best statisticians in the state that there will be a critical shortage of mathematics teachers during the next five years due to the retirement of nearly one-third of the current mathematics teaching force.

Florida hires more than 7,500 new teachers each year. Approximately 50% of these teachers come from out-of-state. Through the efforts of the Center of Career Development Services, the 1-800 telephone numbers and the Great Florida Teach-In, recruitment has been successful. In addition, ongoing monies provided by the legislature supports inservice institutes for teachers and additional opportunities in inservice education throughout the year for adding "certificated" areas to current certificates. The Office of Student Financial Assistance in the Department of Education oversees the Critical Teacher Shortage Trust Fund that identifies and establishes other financial

assistance programs. The state of Florida has several incentive programs for teachers and would be teachers (F.S. 231.625). Funds are available for scholarships/loan forgiveness trust programs that are made available to upper-division undergraduates and graduates. Four thousand dollars for a maximum of two years is available to undergraduates studying mathematics, science, computer education and special education. One year's loan may be forgiven for every two years taught. A second program provides for payment of up to $5,000 per year for two years for graduate students (postsecondary teacher preparation graduates). Funds are provided for loan repayment for current science and mathematics teachers (up to $78/credit hour) as tuition reimbursement for current teachers who study mathematics or science, or for professionals in shortage areas who pursue certification course work.

In the last year, the Master's Fellowship Loan Program has been created to provide as much as $6,000 plus tuition and fees for two semesters and two summer sessions to liberal arts graduates who are seeking a master's degree in education. Two hundred and fifty thousand dollars have been appropriated for this program. The most promising teacher trust fund, also enacted in the past year, has appropriated $500,000 for high school seniors who commit to teaching. Four thousand dollars per year for four years is awarded. Other programs include the Challenger Astronauts Memorial Scholarship Program and the Christa McAullif Ambassador for Education Program to promote teaching as a profession. Finally, 5 out of 67 Florida districts have developed or adopted approved training programs for add-on certification in areas of science (general science 7-9, science middle school, physics 9-12, biological science 7-12, and chemistry 9-12).

Certification Requirements

The Regular Certificate (K-12), valid for five years, requires at least six and no more than 12 semester hours in biological sciences, physical sciences and mathematics. The Elementary School Certificate requires three semester hours in nature study or science and arithmetic methods of teaching. The Junior High School (7-9) and Middle School (5-8) Certificates require 12 semester hours in mathematics, including algebra or higher math courses, and 18 semester hours in science including a minimum of one course in biology, physical science and earth science. Secondary School certification requirements include 21 semester hours in mathematics (including credit in calculus) and 20 semester hours in science (either biology, chemistry or physics). (These are all new certification laws effective beginning July 1988).

The state is also currently changing over to the following science certificated areas: general science 6-9, biological science 7-12, physics 9-12, chemistry 9-12, and earth-space science 7-12.

Alternative Certification

Florida recently established the Experimental Alternative Certification Program for Secondary Education designed to remedy teacher shortages in science, mathematics and other critical teacher shortage areas. To be eligible, a candidate must have a bachelor's degree from a standard institution with a degree major in the subject or field to be taught, a cumulative GPA of 2.75 on a 4.0 scale, a valid Florida temporary certificate, completion of at least 30 semester hours credit in the subject or field of his or her degree major other than in a college of education, a passing score on a subject area exam in the instructional assignment and successful completion of a modified beginning teacher program. Forty teachers are currently enrolled in this experimental modified

beginning teacher program for the 1986-87 school year. Six out of 67 districts have approval for this experimental program. In 1985-86, 15 teachers were enrolled in this program, with only 4 out of 67 districts participating.

Teacher Training

The state, utilizing state education agency Title II funds for teacher training purposes, in an effort to complement present state initiatives, has completed the following projects:

1.	Elementary Science Improvement Package	$ 8,550
2.	Laboratory Safety Manual	$ 17,750
3.	Computer Literacy Curriculum Material	$ 38,329
4.	Symposium for University Science Teacher Educators	$ 9,050
5.	Video Production -- "Safety in the Science Laboratory"	$ 18,000
6.	Kindergarten Level Mathematics Superstars Program	$ 18,000
7.	Summer Symposium in Science, Math and Computer Education For Elementary Teachers in Rural Areas	$ 55,500
8.	Earth Science Source Book for Florida	$ 10,000
9.	Elementary Science Status Survey	$ 2,000
	Total State Education Agency Monies	$177,179

An amount of $9,452,581 was spent in the summer of 1987 on inservice programs to upgrade content areas in science, mathematics, computers, foreign languages and reading for K-12 teachers. The state is also sponsoring a newly formed, middle grades resource center at the University of South Florida. It provides middle grade (4-9) teachers with information in all subject areas.

The annual, intensive Teacher Training Symposium provides training sessions for people involved in the planning, conducting and evaluating of summer institutes for teachers of science. These funds can only be used for programs to add a subject or teaching field to a certificate or to extend a certificate. For the summer of 1987, emphasis had to be placed on science and mathematics content instruction for elementary and secondary teachers, especially those who are out-of-field.

Staff Development Needs

Elementary teachers need updating in both process and content skills related to science. In addition, small rural areas (districts) often have inservice needs for one or two individuals whose needs are not currently being addressed. These may include specific upper-level courses of calculus, AP courses and the like.

Elementary teachers also need more training in the use of manipulatives and physical demonstrations related to mathematics. All mathematics teachers need more training in problem solving, critical thinking skills, and teaching probabilities, statistics and estimation.

FUNDING

The use of Title II funds varies from district to district. Since there are 67 districts in Florida, monies are being spent in many different ways. Some of the larger districts are supplementing summer opportunities for teachers especially in the area of elementary science and mathematics. Smaller districts are dividing the money up between the individual schools or pooling their funds with other small districts to offer better inservices.

Additional funds ($2,203,477.00) for science laboratories in grades 9-12 has been appropriated by the legislature. In addition, the State Science and Engineering Fair receives $20,000.

RECENT STATE REFORMS/NEW INITIATIVES

Most major science education reforms were mandated by the legislature beginning in 1985 and are still currently being implemented. These reforms have promoted science instruction in the following ways: uniform course offerings, identification of a true science course for credit (i.e., photography and aerospace are no longer acceptable), curriculum framework development for grades 9-12 and 6-8 courses, more monies for teacher training in science, changes in teacher certification requirements and increased interest in science. These reforms have hindered science instruction in the following ways: the courses "Principles of Technology I and II" are offered for science credit instead of vocational credit, and other vocational courses can be substituted for science courses and credit.

TRENDS AND ISSUES

The three biggest problems that the state of Florida faces in improving science and mathematics instruction are:

1. Growth. In the next decade Florida will need 573 new elementary schools, 174 new middle schools and 94 new high schools. The cost for this construction is rated at a staggering $8.8 billion for growth alone. Florida will become the fourth largest state in terms of population by the end of 1987.
2. Teacher Shortage. Currently, about 1.5% of Florida's teachers retire annually, while about 6% resign for other reasons. This alone creates 6,000 new vacancies each year. It is estimated that 40% the current Florida teaching force is leaving the teaching profession within the next 10 years.
3. Capital Funding/Class Size. Funding for materials and equipment is not adequate. In 1981, the national average for science materials and lab equipment (not necessarily the optimum) was $9.48 per student in grades 10-12. In Florida, a random survey of 61 high schools showed an average of $4.03 — less than half the national average. In addition, the legislature does not supply categorical funding for middle and junior high school science programs. Students enrolled in grades 9-12 science generate the same amount of money per pupil as they do in English, foreign languages and algebra.

GEORGIA

CURRICULUM

Curriculum Guides

The Georgia state education agency has developed required science objectives for grades K-12. These objectives are being revised in 1987.

Currently, Basic Curriculum Content — minimum mathematics curriculum requirements by grades or courses — exists for grades K-12. In spring 1988, the Basic Curriculum Content is scheduled to be replaced by new curriculum guidelines called Quality Core Curriculum. Both have been developed by the Georgia Department of Education. Local curriculum guides must follow these state-established guidelines. In 1981, the specific Basic Curriculum Content for grades 9-12 (Mathematics for Georgia Secondary Schools) were revised. In 1982, the specific content for grades K-4 (Personalizing Education for Children) and grades 5-8 (Mathematics for Georgia Middle Grades) were revised.

Higher Order Thinking Skills

Higher order thinking skills are addressed within the regular science curriculum, and the state education agency is looking at objectives that emphasize higher order skills in all subjects. Teaching of higher order thinking skills has been a major focus of statewide teacher and supervisor meetings, conferences and inservice workshops in the 1980s.

Time Requirements

Science and mathematics are required to be taught in elementary and middle school; however, there are no state guidelines regarding the quantity (amount of time) students spend on science or mathematics instruction. High school students must spend 150 hours per school year in science and mathematics for two years to meet graduation requirements.

Graduation Requirements

Effective for the graduating class of 1988, two units of science and two units of mathematics are required in Georgia. Computer technology is one unit (if elected from three choices).

The Quality Basic Education Act of 1985 directs the State Board of Education to develop a statewide basic curriculum that requires competencies that all students must master before graduation from high school. Three units of mathematics are required for a college preparatory seal of endorsement on a student's diploma.

STUDENTS

Recognition and Awards

Science recognition programs in Georgia include the designation of October as Hi-Tech Month which features student and teacher recognition programs. Georgia students also participate in national programs such as those sponsored by the U.S. Department of Energy, the West Virginia National Youth Science Camp and the Super Comp Program.

The Georgia State Board of Education Excellence Award in Mathematics is given on the basis of exceptional accomplishments in mathematics, performance on the American High School Mathematics Examination and the Georgia Mathematics Tournament. Students in grades 9-12 are eligible to receive this award.

Summer Institutes, Magnet and Residential Schools

The Governor's Honors Program (GHP) in Georgia is a six-week summer instructional program designed to provide intellectually gifted and artistically talented high school students (rising juniors and seniors) with challenging and enriching educational opportunities. Approximately 600 students attend GHP each summer at Valdosta State College; approximately 100 of these have mathematics as their major area of study.

The state education agency in Georgia provides consultation to school districts that develop magnet schools. About 25,000 students are now enrolled in magnet schools, organized for the most part around mathematics, science, the arts, the humanities or international education.

Special Populations

Futurescape was a program sponsored by the Georgia Department of Education and the Board of Regents of the University System of Georgia to conduct 14 seminars in 1986 at colleges and universities throughout Georgia. Futurescape Seminars allowed and encouraged high school women in grades 9-10 to meet professional women (role models) whose careers are dependent on an educational base in science and mathematics. Some colleges continue to fund and conduct Futurescape Seminars in 1987.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

Problem-solving sections are included on the state-developed criterion-referenced tests (CRTs) in reading and mathematics.

Assessment Content

Assessment content is determined by teacher committees and correlated with the state-mandated curriculum.

Assessment Reporting

Assessment results are reports for the state, districts, schools and students. Results for the state, districts and schools are made public. Student results are only available to parents.

Assessment results are intended to provide information about student achievement teachers, parents, students, to educational policy makers and decision-makers and concerned citizens. Information is collected to answer questions regarding the extent to which students are acquiring essential academic skills. The information is used in instructional planning and in evaluating the effectiveness of the educational program.

Individual student results on the norm-referenced tests (NRTs) are useful in helping teachers to determine the level of instruction for a student or group of students. The results of the CRTs aid teachers in pinpointing specific skills that may need attention.

Districts use the tests as an aid to local administrators and instructional supervisors in identifying some of the strengths and weaknesses in instructional programs as well as possible gaps in the curriculum. They are also useful in establishing priorities for allocation of resources, staffing, selection of instructional materials and planning needed staff development.

State education policy makers use the results to monitor the achievement and needs of students throughout the state and to develop policies relating to curriculum, instruction, certification and administration.

Subject Areas Assessed

Mandatory student tests in Georgia are as follows:

(CRTs= criterion-referenced tests; NRTs= norm-referenced tests; BSTs= basic skills tests)

Kindergarten students take a 1st grade readiness test

Students in grades 1, 3, 6 and 8 take CRTs in reading and mathematics; the 6th and 8th graders are also tested in writing.

Students in grades 2, 4, 7 and 9 take NRTs in reading, language, mathematics, science and social studies.

Tenth graders take BSTs in reading, mathematics and writing.

TEACHERS

Teacher Recruitment and Retention

The Georgia Student Finance Authority awards Direct Student Loans for teacher training in mathematics, science and special education. Student applicants must have at least a 2.75 overall GPA and their families' income must be taken into consideration. (Students are eligible to receive interest-subsidized guaranteed student loans if their families' adjusted gross income is less than $30,000. Students are eligible to receive nonsubsidized loans if their families' adjusted gross income is greater than or equal to $30,000). This loan program became effective April 4, 1985. Also available is a Service Cancelable Loan, available for teacher training in mathematics, science and special education. Applicants are required to show their adjusted gross annual income and may receive up to $1,500 per year. One year of teaching in the field will cancel one year of funds received.

Teacher Shortages

There is always a need for good, qualified science teachers, especially at the elementary level. Shortages are addressed through the student loan programs described above and an alternative certification program noted below.

School systems are vigorously recruiting mathematics teachers from both within and outside of Georgia. The Georgia Department of Education has recruited mathematics teachers from West Germany. The Department was awarded a grant from the Council of Chief State School Officers - Foundation School/Collaboration Project to develop recruitment techniques to encourage exceptional people to enter the teaching profession.

Certification Requirements

Elementary certification (grades K-4) requires undergraduates in a general education program to take 10 quarter hours in either science or mathematics, or a combination of science and mathematics. Middle school/junior high school certification to teach science (grades 4-8) requires a primary concentration in science (25 quarter hours) or a secondary concentration in science (20 quarter hours). The minimal state certification requirement to receive middle school/junior high certification is 10 quarter hours in mathematics. However, middle grade certification allows prospective teachers to select a major content area (requiring 25 quarter hours) and a minor content area (requiring 20 quarter hours). Mathematics may be either a major or minor area of specialization. Secondary certification requires 45 quarter hours in mathematics. However, Georgia is currently revising secondary certification criteria in mathematics to include a minimum of 60 quarter hours in mathematics and mathematics education.

Candidates are required to complete a fifth year of professional education study to become certified and must pass a teacher competency and performance assessment.

Alternative Certification

Under the 1985 Quality Basic Education Act, people who have not completed a teacher education program may receive renewable certificates. Certification requirements include a bachelor's degree in the subject area to be taught, one course in human growth and development, a one-year internship, passing scores on the teacher certification test and the teacher performance assessment instrument, 10 quarter hours in curriculum and methods, and a course in teaching exceptional children. Five people have taken the alternative certification route in mathematics.

Teacher Training

To upgrade the skills of science teachers, the state education agency works with colleges and universities, provides services to local education agencies through consultants who work with the school systems, provides information and research findings and conducts workshops.

The Georgia Department of Education provides consultant services to local school system, conducts regional and statewide workshops, works with college and university personnel, provides information, and supports the Georgia Council of Teachers of Mathematics, the Georgia Council of Supervisors of Mathematics and local educational groups in their efforts to improve mathematics education.

Staff Development Needs

The greatest staff development needs among science teachers in elementary school are more content knowledge in areas of science and to overcome "science anxiety." In addition, teachers need materials and activities that address the objectives in the science curriculum.

The greatest staff development need among mathematics teachers is to be provided informative, practical and motivational inservice programs that bring teachers up-to-date on content and curriculum changes. Changes include appropriate use of technology (calculator and computers) in the classroom and implementing research results on effective mathematics teaching (including using manipulative materials).

FUNDING

Seventy percent of Title II monies goes to school districts and is used to provide workshops for science and mathematics teachers, computer training in computer-assisted instructional activities, funding for teachers to attend conferences or to take college courses, and to buy classroom equipment and supplies. Twenty percent of Title II monies is dispersed to districts for exemplary programs and for innovative grants. In addition, Georgia's Quality Basic Education (QBE) Act provides money through innovation grants and incentive award grants and allows for more staff development programs.

RECENT STATE REFORMS/NEW INITIATIVES

With passage of the Quality Basic Education Act, Georgia changed its funding formula to a weighted full-time equivalent system in which students enrolled in certain classes earn more money for the school system than other students. The funding formula is based on the assumption that it costs more to provide instruction for certain classes than it does for others. Science laboratory courses, for example, earn more money for the school system than English courses because science laboratory equipment is more expensive than English textbooks. Therefore, students are encouraged to take higher level science classes. Another new initiative is that the state is now using the Iowa Test of Basic Skills, which includes a science component. When teachers realize students will be tested in science, they will start teaching more science.

TRENDS AND ISSUES

The biggest problem Georgia faces in improving science instruction is developing a set of activities for teacher inservice that relate to the curriculum objectives. For example, teachers need to start dealing with physical science at the lower grade levels, which will require more adequate preservice and inservice training.

The four biggest problems the state faces in improving mathematics instruction are:

1. The shortage of certified mathematics teachers;
2. The need to revise (strengthen and update) certification and mathematics teacher preparation requirements;
3. Creating a Quality Core Curriculum that details mathematics objectives in grades K-12; and
4. Providing inservice to 186 public school systems in Georgia with limited resources in terms of money, time and personnel.

HAWAII

CURRICULUM

Curriculum Guides

Hawaii has Foundation Program Objectives and related Student Performance Expectations, Program/Curriculum Guides with learner outcomes and Authorized Courses/Code Numbers with descriptors. Computer education also has a Plan for Computers in Education, an Exploratory Computer Literacy Framework and a Computer Science Framework. All were developed by the state education agency's Office of Instructional Services. Foundation Program Objectives and Authorized Courses/Code Numbers are required; Program/Curriculum Guides are recommended.

Higher Order Thinking Skills

Curriculum improvement efforts have been initiated to focus on teaching thinking skills in all content areas. At the elementary level, Title II funds are being used to develop higher order thinking and application skills using the integrated approach of Project AIMS (Activities for Integrating Mathematics and Science). At the secondary level, problem solving has been the major improvement focus in all courses. Application skills development is also emphasized.

Time Requirements

One hundred fifty minutes per week of science instruction are recommended for grades 5 and 6; 250 minutes per week are recommended for grades 7 or 8 and grade 9.

One hundred eighty minutes per week of mathematics instruction are required for grades 1-3, and 200 minutes per week are required for grades 4-6. Students must complete one credit of mathematics in grade 7 or 8 and two credits in grades 9-12.

Graduation Requirements

Since 1978, Hawaii has required two credits of science and two credits of mathematics for high school graduation. Students must also demonstrate mastery of basic competencies prior to graduation. No changes in these requirements are being proposed.

STUDENTS

Recognition and Awards

Individual school honors programs, district and state science fairs and student symposia exist to recognize student achievement in science. The Department of Education annually conducts the Program for Recognizing Academic Interest and Student Achievement — a curricular fair for student achievers in all subject areas.

Summer Institutes, Magnet and Residential Schools

State-supported special schools (such as magnet or residential schools) are currently under consideration. Funding would come from the general operating budget of the Department of Education.

The state supports summer institutes for high school students interested in science and mathematics. Based on teacher recommendations and a panel review, approximately 180 students are selected to participate in a six- to seven-week summer science and mathematics program. Course offerings include chemistry, biochemistry, oceanography, computer sciences, engineering and integrated physics/calculus.

Special Populations

Programs that address the needs of special populations are incorporated in the existing science curricula. They include such activities and programs as the Enrichment in Science Program, the Summer Program for the Enrichment of Basic Education and advanced placement courses in chemistry, physics and biology.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

Higher order thinking skills are not directly addressed in Hawaii's standardized achievement testing. However, one of the state's criterion-referenced test objectives — "reach reasoned solutions" — incorporates some aspects of higher order thinking through multiple choice test items.

Assessment Content

The Department of Education's curriculum section has generated a set of common objectives for all schools. These objectives form the basis for all of the state's assessment, whether through standardized tests or criterion-referenced tests.

Assessment Reporting

Assessment results are reported for the state, for districts, schools and students. Results for the state, districts and schools are made public.

Schools use assessment results to diagnose individual student achievement and to assess their curricula and programs. Districts use assessment results to assess schools and programs. State education policy makers use assessment results to assess schools, districts and programs.

Subject Areas Assessed

Students in grades 3, 6 and 8-12 are annually tested in mathematics and reading. Students in grades 3, 6, 8 and 10 are also tested in writing and language arts. In addition, students in grade 3 are tested in social studies.

TEACHERS

Teacher Recruitment and Retention

Recruitment and retention are major objectives in "The Department of Education's Plan of Action to Minimize Future Teacher Shortages for 1985-1990." As an incentive, the state pays tuition costs of students enrolled in science or mathematics teacher

education. There are also continued staff development activities and curriculum support for science and mathematics teachers.

Teacher Shortages

To address its science and mathematics teacher shortage, the state offers alternative certification to individuals who have degrees in science or mathematics. Other means of addressing the shortage include retraining programs for current teachers in science or mathematics as well as the recruitment and retention programs described above.

Certification Requirements

For certification in elementary education, individuals are required to complete 12 credits of science and six credits of mathematics, including three credits in mathematics methodology. There is no special certification for junior high school beyond the normal secondary certification. For secondary certification in science, individuals must complete 36 credits of science course work; for secondary certification in mathematics, 33 credits, including three credits in mathematics methodology. Hawaii also offers a fifth-year Professional Diploma Program to individuals who already have a bachelor's degree.

Alternative Certification

Due to teacher shortages in science and mathematics, professionals may enter a special teacher certification program that allows them to teach while simultaneously completing all regular certification requirements. Thirty-one individuals have received certification through this alternate route since the program began in 1985.

Teacher Training

On-going inservice training programs are conducted throughout the school year at district and state levels. Science and mathematics institutes, resource centers and higher education institutions provide services to upgrade teacher skills.

Staff Development Needs

Staff development needs among science and mathematics teachers include the implementation of various instructional strategies and the enhancement of thinking and problem-solving skills.

FUNDING

Districts are using Title II funds to develop integrated science/mathematics programs for elementary school teachers. The programs focus on higher order thinking and application skills development. Title II funds are also being used to conduct demonstration /dissemination training activities for secondary science and mathematics teachers. Additional state monies have been used for curriculum improvement in science and mathematics education.

RECENT STATE REFORMS/NEW INITIATIVES

There have been no recent reforms that have affected science or mathematics instruction.

TRENDS AND ISSUES

The three main problems Hawaii faces in improving science instruction are:

1. Improving elementary science education;
2. Encouraging science majors in college to enter the field of education; and
3. Improving scientific literacy levels of all students.

The state's main problems in improving mathematics instruction are:

1. Solving the teacher shortage;
2. Increasing instructional skills development in problem solving, thinking and applications; and
3. Increasing the use of technology in mathematics education.

IDAHO

CURRICULUM

Curriculum Guides

In 1986, the Idaho State Department of Education developed a required course of study that includes minimal course descriptions for 9th grade earth science and 10th grade biology.

The mathematics Course of Study Guide, revised in 1987, allows districts three options for providing mathematics instruction for all students in grades 9 through 12.

Higher Order Thinking Skills

Higher order thinking skills in science are emphasized in school accreditation reviews as one of the priorities considered during curriculum planning and are included in course descriptions. Higher order skills are also stressed in four one-week workshops, mainly in environmental education, offered every summer.

Regional mathematics teacher training emphasizes higher order thinking skills using Title II monies.

Time Requirements

Idaho now requires 50 minutes per week of science instruction for grades 1 through 6, and 75 minutes per week of science instruction for grades 8 and 9. Students in grades 7 through 12 receive 250 minutes per week of science instruction.

New time requirements have been passed by the State Board and are scheduled for public hearings in early 1987. The proposed change would require science instruction as follows:

Grades 1-3 — 50 minutes per week
Grades 4-6 — 120 minutes per week
Grades 7-9 — 250 minutes per week
Grades 9-12 — 250 minutes per week

Idaho requires students in grades 7 through 12 to take a minimum of five 47-minute classes in mathematics.

Graduation Requirements

Effective with the graduating class of 1988, two units of science (one of the science units must be at least 70 hours of actual lab experience) and four units of mathematics are required in Idaho. Since 1985, students must take the Idaho Proficiency Test prior to graduation. Those who pass all four subtests receive a Seal of Proficiency on their diplomas. Students must also achieve a "C" average for graduation.

Idaho colleges just raised their entrance requirements to three science credits (at least one in physical science and one in biology); college entrance criteria are in effect the de facto science requirements in the state.

No changes in the graduation requirements have been recently proposed.

STUDENTS

Recognition and Awards

Idaho science students participate in the Intermountain Junior Science and Humanities Symposium, sponsored by the University of Utah, at which high school juniors present research papers. The program encourages students to do independent research.

The state education agency sponsors a program for gifted students in all grades (however, requirements for entry virtually mandate that the students be high school seniors). Eight Idaho students participate annually.

In 1987, the Centennial Scholarship Program, sponsored by the governor's office, selected one student from each state to go to Washington, D.C. with a teacher.

Mathematics recognition programs for students in grades 7-12 include Math Counts, National High School Mathematics Examination (NHSME) and the Academic Decathlon.

Summer Institutes, Magnet and Residential Schools

The University of Idaho and National Research Management sponsor a one-week workshop for junior high school students and teachers. Participants are selected on a geographical basis (two students for each legislative district). Approximately 90 students are selected, but more can be accepted.

Idaho students are also eligible to participate in the West Virginia National Youth Science Camp. Two seniors attend a two-week summer workshop covering every field of science, including astronomy, exploring caves, physics, etc.

Special Populations

The state education agency is planning a conference that will provide high school girls with information on careers in science or mathematics. In addition, a number of workshops on sex equity are administered by the state education agency, conducted by a sex equity consultant. These are primarily for high school students and teachers but are open to younger students.

STATE ASSESSMENT

Assessing Higher Order Thinking Skills

Selected test items include various levels of thinking skills development that assess higher order skills.

Assessment Content

Test objectives are reviewed by state education agency content area specialists who work cooperatively with the test coordinator to promote maximum use of test results.

Assessment Reporting

Assessment results are reported for the state, districts, schools and students. Only state results are made public.

The state education agency actively promotes schools' use of assessment results to determine instructional, guidance, administrative and research potentials. Districts are encouraged to use the results for administrative and research purposes. Assessment results are intended for use by state education policy makers in administrative decision making, for research purposes, to establish consultation priorities, to aid in accreditation reviews, etc.

Subject Areas Assessed

In 1987, reading, mathematics, language arts, reference skills, social studies, science and direct writing assessments will be conducted for all students in grades 8 and 11. In 1988 and beyond, assessments in these same subject areas are planned for all students in grades 6, 8 and 11.

TEACHERS

Teacher Recruitment and Retention

Idaho uses Title II funds to recruit and retain science and mathematics teachers through scholarships to students or teachers who want to become recertified. In addition, the state is taking 50 teachers to AMES in California for research in science, and the state sponsors a Science Day where teachers and students are taken to Mountain Home Air Force Base for workshops in science and high technology.

Teacher Shortages

The state is addressing shortages of mathematics teachers through consultation with colleges and universities. A shortage of qualified science teachers is considered a real problem. State officials are trying to encourage those people who are misassigned to become recertified in science and are promoting various programs designed to upgrade teachers' skills.

Certification Requirements

Elementary school certification (grades 1-8) requirements include eight semester hours in one or more areas of natural science and six semester hours in fundamental arithmetic. Secondary school certification (grades 7-12) requirements are based on the area of specialization. Biology teachers are required to complete at least six semester hours in botany and six in zoology; courses in physiology are also recommended. Physical science teachers must complete at least eight semester hours of chemistry and eight semester hours of physics. Mathematics teachers are required to take courses in algebra, geometry and trigonometry.

Science and mathematics teachers are required to earn six semester hours of training every certification period (every five years).

Alternative Certification

If a school district can demonstrate that it has made an attempt but is unable to hire a fully certified person, it can appeal to the state board for special permission to hire, for one year, a teacher without the required credentials. Contracts are almost never renewed for a second year, and in the past 10 years, this option has been exercised for science teachers less than a dozen times.

The state education agency is reportedly looking at proposed alternative routes to certification in all disciplines.

Teacher Training

In addition to the recruitment and retention activities indicated above, Idaho is sending science teachers to NSTA conferences as initial stimulus to inspire them to return to school (20 will be going to Washington, D.C. this year).

Staff Development Needs

The greatest staff development need for science teachers is in methodology rather than subject matter. Science teachers need help in classroom management, safety training, methods of science and lab experience.

Mathematics teachers' greatest staff development needs are related to curriculum development and increased certification requirements in mathematics for elementary teachers.

FUNDING

Districts are using Title II funds for mathematics inservice expenses, workshops or courses. Title II monies are also used to sponsor science workshops locally. These workshops are designed to fulfill the needs expressed in teacher surveys.

No state funds or other resources have been made available to target science instruction at the district level, and very little additional funding is available for mathematics instruction.

RECENT STATE REFORMS/NEW INITIATIVES

The only recent reform or initiative reported is a statewide teacher testing program for certification.

Factors that hinder science instruction in Idaho include inadequate funding, use of out-of-date texts (districts can't keep up with the adoption schedule), lack of adequate equipment and supplies and a mass exodus of teachers from the state and the profession.

TRENDS AND ISSUES

The three biggest problems facing Idaho in improving science instruction are:

1. Lack of funding;
2. Lack of emphasis of importance of science instruction; and
3. Exodus of teacher due to lack of funding and low salaries. This creates overloading teachers who remain with too many classes and too many students in each class.

The three biggest problems facing Idaho in improving mathematics instruction are:

1. Attracting and/or retaining mathematics teachers;
2. Curriculum development; and
3. Upgrading elementary mathematics teachers' skills.

ILLINOIS

Illinois did not provide answers to the specific survey questions related to science or mathematics curriculum.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

Assessment Committees in each fundamental learning area are addressing the issue of higher order thinking skills. Committee findings may at some time result in different testing strategies. For example, in science, students may be asked to write an essay rather than answering a series of multiple choice questions.

Assessment Content

Illinois' State Goals for Learning outlines goals that are consistent with the purpose of schooling in six fundamental learning areas: language arts, mathematics, biological and physical sciences, social studies, fine arts, and physical development and health. These goals were developed by curriculum committees in conjunction with assessment staff consultants. Currently, assessment committees are reviewing items with state curriculum staff and consultants. The key documents are Sample Learning Objectives in the six Fundamental Learning Areas. Each of the Sample Learning Objective documents list "Knowledge and Skill" statements and objectives for each goal.

Assessment Reporting

Assessment results are reported for the state, districts, schools and students. Results for districts and schools are made public.

Schools use state assessment results to monitor their own progress. Districts use results to monitor their progress as well as to plan district improvements. State education policy makers use results for allocation of resources and as a basis for school improvement activities.

Subject Areas Assessed

In 1988, every student in grades 3, 6 and 8 will be tested in reading. In 1989 and 1990, every student in grades 3, 6 and 8 will be tested in reading and mathematics. Additionally, in 1990, every student in grades 3, 6, 8 and 10 will be tested in language arts, science, reading and mathematics.

INDIANA

CURRICULUM

Curriculum Guides

Indiana's recommended Proficiency Guides for grades K-12 were recently developed in most subject areas by the state education agency and writing committees that consisted of local and university educators in each discipline. The guides are still in the evolution process; release of the final draft was scheduled for June 1987. Workshops are being planned to introduce and disseminate the guides.

Higher Order Thinking Skills

The entire emphasis of the Proficiency Guides is the teaching of higher order thinking skills. In the area of science, process skills, problem solving (as distinguished from science inquiry) and science in societal issues are emphasized. In the area of mathematics, process skills rather than isolated skills are emphasized.

Time Requirements

Indiana recommends 150 minutes per week of science instruction for grades 1-3, 180 minutes per week for grades 4-5 (and grade 6 if it's taught in an elementary school), 200 minutes per week for grades 6-8 and 250 minutes per week for grades 9-12.

It is recommended that 225 minutes per week be devoted to mathematics instruction in grades 1-6, 200 minutes per week in grades 7-8 and 250 minutes per week in grades 9-12.

Graduation Requirements

A credit in Indiana is the equivalent of 250 minutes of instruction per week per semester. Two credits each are required for science and mathematics for high school graduation. Beginning with the class of 1989, four credits each in science and mathematics will be required. District, state or commercially produced instruments for test results can be used at local option in determining a student's eligibility for a high school diploma. School corporations may prescribe a number of majors or minors that a student might achieve before graduation.

The board recently approved an Academic Honors Diploma that requires six credits in science, including two credits in biology, two credits in chemistry or physics and two credits in biology, chemistry, physics or space science. At least a "C" grade average in the science courses and an overall "B" average must be achieved.

STUDENTS

Recognition and Awards

The majority of recognition programs for outstanding students in science and mathematics are held at the local level; however, the state participates in several national recognition programs. Such programs include the National Science Fair, the Indiana Talent Search and the Junior Academy of Science, the latter two of which are

sponsored by the Indiana Academy of Science. The Indiana Council of Teachers of Mathematics also sponsors a student recognition program.

Summer Institutes, Magnet and Residential Schools

A bill is currently in the legislature that proposes a state-supported residential school to be located at Ball State University. Students in grades 9-12 would be eligible to attend; selection criteria has not yet been determined. A governor's school is also under consideration. Fifty percent of the courses offered during the five-week summer program would focus on science and mathematics and a scattering of courses would cover in other areas. A specified number of juniors and seniors from each public high school in the state would be selected to participate on the basis of a competitive application process.

Some of the state's universities sponsor their own summer programs. For example, Purdue University invites several outstanding high school seniors from across the nation to participate in its eight-week science summer program. After a two-week orientation, students work with scientists for six weeks in laboratory environments.

Special Populations

There are currently no statewide programs specifically designed to increase the participation of underrepresented populations in either science or mathematics.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

Indiana addresses higher order thinking skills in its assessment program by prespecifying a domain that includes higher order thinking skills.

Assessment Content

Domain objectives (e.g., assessment content) are part of the state's educational proficiencies that are found in the Proficiency Guides.

Assessment Reporting

Assessment results are reported for the state, for districts, schools and students. The state and districts' assessment results are made public by the state education agency under the Public Records Act interpretation by the State Attorney General; the schools' assessment results are made public by local districts.

State assessment results are used by schools to identify students needing remediation and to help plan summer and/or fall programs of remediation. Districts use the results to disburse funds targeted for remediation and to plan district-wide remediation programs. The state education agency uses results to determine disbursal of remediation funds and to report the results to the state board and legislature.

Subject Area Assessed

During the 1987-88 school year, every student in grades 1, 2, 3, 6, 8, 9 and 11 will be tested in language arts, writing and mathematics. During the 1988-89 school year, every student in grades 3, 6, 8, 9 and 11 will be tested in language arts, writing, mathematics, social studies and science. During that same academic year, every student in grades 1 and 2 will be tested only in language arts and mathematics. Test content and grade levels assessed are determined one biennium at a time; therefore, no information is available for 1989 and 1990.

TEACHERS

Teacher Recruitment and Retention

Over the last four years, the state has funded a loan forgiveness program for teachers. It is uncertain whether the program will be refunded in 1988. The state also funds a grant program for teachers who want to convert from another subject area to one of critical need.

Teacher Shortages

A study conducted by two researchers at the University of Indiana documented the shortage of certified science and mathematics teachers to be only 1%. Therefore, there is no statewide effort to address the issue of teacher shortages.

Certification Requirements

The Kindergarten-Primary (K-3) certificate requires 40 hours in general education, including science and mathematics. The Elementary Education certificate (grades 1-6, and nondepartmentalized 7 and 8) requires 70 hours in general education, including science and mathematics. The Junior High/Middle School Education Certificate's (departmentalized grades 5-9) general education component requires 8-12 semester hours of biology, physics, chemistry, geography, geology, astronomy and mathematics, in any combination. An additional 18-24 semester hours in science (including biology, chemistry, physics and earth-space science) or 18-24 semester hours in mathematics (including college-level mathematics such as statistics, probability, finite math, geometry and number theory adapted to the junior high/middle school level) must be taken by teachers specializing in that subject area. The Secondary School Education Certificate has the same general education requirements as the Junior High/Middle School Education Certificate; however, it also requires 24 semester hours of course work in the primary endorsement area and 15 semester hours of course work in the secondary endorsement area.

Alternative Certification

An alternate route to certification is not available in Indiana.

Teacher Training

Programs funded by Title II monies are the only programs that upgrade the skills of science and mathematics teachers.

Staff Development Needs

There is a need among the state's science teachers to learn how to teach cognitive skills. Science teachers also need to be updated on current information in their field.

FUNDING

Districts are using Title II funds in various ways. These funds are distributed as follows.

28.32% — inservice in mathematics
27.16% — inservice in science
25.70% — instructional materials
11.92% — computer learning and instruction
3.08% — teacher retraining in science
2.18% — teacher retraining in mathematics
1.64% — foreign language instruction

Additional state monies have not been allocated specifically for science or mathematics. However, curriculum improvement grants have been awarded to model sites for curriculum development in all subjects. Furthermore, $11 million was appropriated to purchase computers for schools. The state also offers a tax deduction for gift computers given to schools.

RECENT STATE REFORMS/NEW INITIATIVES

The increased graduation and time requirements will promote science instruction by increasing the attention these subjects receive. The new statewide testing program described above under "Student Assessment" will also promote science and mathematics instruction by linking it to the overall, statewide accountability system.

TRENDS AND ISSUES

The three biggest problems Indiana faces in improving science instruction are:

1. Emphasizing the functionality of science;
2. Updating teachers in current trends in science and student needs; and
3. Instilling enough confidence in elementary teachers to make teaching science less stressful.

The three biggest problems the state faces in improving mathematics instruction are:
1. Strongly favored local control;
2. Lack of understanding of what mathematics "is" (mathematics is typically viewed as computational skill development); and
3. De-emphasis on curriculum as a vehicle for change.

IOWA

CURRICULUM

Curriculum Guides

In 1986, the state education agency and advisory committees developed the Iowa Guidelines for six subject areas: the fine arts, foreign language, language arts, mathematics, science and social studies. The guidelines are recommended for use by districts in developing local curriculum for grades K-12.

Higher Order Thinking Skills

Higher order thinking skills are built into Iowa's curriculum guides for all science areas. Process skills are particularly emphasized.

In mathematics, problem solving and the use of manipulatives are emphasized in workshops and staff development programs. In addition, "Training of Trainers Workshops," planned for summer 1987, focused on K-8 mathematics.

Time Requirements

The state does not have any recommendations concerning the amount of time spent on science or mathematics instruction for grades 1-8. However, students in grades 9-12 must receive at least 200 minutes per week of science instruction and 200 minutes per week of mathematics instruction to meet graduation requirements.

Graduation Requirements

In Iowa, the governing authorities for schools or school districts establish and maintain graduation requirements. New requirements are being proposed in which districts would have to offer five science courses and five mathematics courses to students in grades 9-12, rather than the currently required four courses. Districts would still be able to choose the specific courses they would offer.

STUDENTS

Recognition and Awards

The Iowa Academy of Science sponsors a series of award programs for students in grades 7-12. The programs will include younger students in 1988. The Iowa Invention Convention, a program that encourages students in grades 3-7 to create inventions, is currently being proposed. This program would be sponsored by the governor, the legislature and the State Department of Education.

In November of each year, the University of Northern Iowa (UNI) holds the Mathematics Science Symposium. Students are administered a test while attending the symposium, and those with outstanding scores receive scholarships to attend UNI. Other state institutions of higher education have similar programs. Iowa State University is establishing a three-week summer program for gifted mathematics students.

Summer Institutes, Magnet and Residential Schools

The state does not support special schools, such as magnet or residential schools, for students studying science or mathematics. Nor does the state support summer institutes for students studying science or mathematics. However, a proposal to appropriate monies for this purpose is being discussed during the current, 1987 legislative session.

Special Populations

A state mandate requires each district to teach from a multicultural, nonsexist perspective. The education equity staff in the state education agency provides technical assistance and publications, such as Multicultural Nonsexist Education, Math and Science, in Iowa Schools, to assist local districts in textbook selection and the integration of multicultural, nonsexist concepts into instructional programs.

STUDENT ASSESSMENT

No state assessment is conducted by the State Department of Education.

TEACHERS

Teacher Recruitment and Retention

Iowa's science and mathematics loan program is designed to assist current teachers to obtain or upgrade their teaching authorization in science or mathematics.

The Iowa Guaranteed Student Loan Payment is available to students who have graduated from college after January 1, 1983 with a major in science or mathematics and have an Iowa Guaranteed Student Loan to repay. The state of Iowa will reimburse the loan program up to $1,000 for each year of teaching. The maximum reimbursement is a total of $6,000.

The Iowa Science and Mathematics Loan Program is designed for practicing teachers who want to become approved teachers of science or mathematics. The state of Iowa will pay tuition for the advanced training required with forgivable loans. The maximum loan is $1,500, and students must be enrolled at least half-time in an eligible course of study. Students will receive full loan cancellation benefits if they teach science or mathematics in an approved Iowa school for at least two years.

Iowa Lottery Funds to Revitalize Current Mathematics and Science Teachers is a summer institute program that enriches and upgrades job skills of Iowa teachers in shortage areas. The programs pay for tuition, materials, room and board, and a $150 weekly stipend for participants. Four summer institutes were scheduled for science or mathematics teachers for the summer of 1987. Criteria for participant acceptance are established by each grant-awarding institution of higher education.

The Congressional Teacher Scholarship Program is available to students who graduate in the top 10% of their high school graduation class and intend to go into teaching in critical fields identified by the state of Iowa. Science and mathematics are identified critical fields.

Teacher Shortages

Iowa has a shortage of qualified science teachers, especially in chemistry and physics. Several current science teachers are teaching out-of-field. The PRISMS (Problem Solving in Science and Mathematics) program, funded through state and federal monies, is designed to upgrade teachers' background knowledge in science. There are also state-funded inservice programs to upgrade chemistry teachers.

Due in part to the extensive teacher recruitment and retention programs listed in the previous section, Iowa has been able to prevent a serious shortage of mathematics teachers.

Certification Requirements

Currently, elementary certification (K-8) requirements vary according to institutions of higher education. However, effective October 1988, people seeking K-6 elementary certification in a specialty area, such as science or mathematics, will need 24 semester hours of course work in that area. People seeking elementary certification without an emphasis in a specialty area will continue to have to meet the requirements prescribed by the institution of higher education they are attending.

Currently, persons seeking secondary certification (9-12) in general science must complete 48 semester hours of course work — 12 semester hours each in biological science, earth science, physical science and chemistry. To receive secondary certification in one of these areas, a major in that area must be earned plus nine semester hours of course work completed in each of the remaining areas.

As of October 1988, people seeking secondary certification (7-12) in science must complete either 24 semester hours in each of the four subject areas listed above or 30 semester hours in a broad subject area with 15 semester hours in one concentrated area.

For secondary certification in mathematics people must complete 30 semester hours of content course work as of October, 1988. Those who hold a secondary certificate in an area other than mathematics may add a mathematics endorsement to their certificate by completing 24 semester hours of course work including algebra, geometry, calculus and computer programming.

Alternative Certification

Iowa may grant temporary certification to people who lack only a few of the required courses to become fully certified. All lacking course work must be completed within one year. The state is exploring other alternate routes, such as content testing.

Teacher Training

The state offers a number of programs to upgrade the skills of teachers with Title II funds. PRISMS, a chemistry inservice, a K-3 science inservice, the Aerospace/Aviation Project, the Iowa 4-9 Science Project, secondary safety workshops and the Biology/Genetics Project are all examples of such programs.

The Department of Education has developed and piloted materials and a workshop for upgrading the skills of middle/junior high school level mathematics teachers. Content and teaching strategies focus on the mathematics curriculum guidelines. Other workshops are planned for elementary level teachers. In the future, workshops will be planned for high school mathematics teachers.

Staff Development Needs

At the elementary level, the awareness of and concern for science needs to be increased. The same problem applies to physical science in grades 7-12.

A need among mathematics teachers is understanding that mathematics is more than computation. Mathematics teachers also need to use manipulative and effective teaching methods. In addition, they need to incorporate concepts and content related to quantitative literacy, discrete mathematics and the use of technology into the curriculum.

FUNDING

Districts are using Title II funds for staff development programs, one-day inservice meetings focusing on selected topics in science and mathematics, and costs associated with teachers' attending professional meetings. Additional monies raised through the state lottery also contribute to improving public education.

RECENT STATE REFORMS/NEW INITIATIVES

The five-year plan, developed by the Department of Education, outlines certain stipulations that have promoted science instruction. First, all educational standards (i.e., curriculum, assessment, time) had to be reviewed and revised where necessary. Second, by 1989, all districts must have on file the curricula taught in their schools. By 1990, districts must begin assessing student achievement within their curricula. Third, the State Department of Education was directed to develop a curriculum development guide for each of six subject areas (including science) and to disseminate them to every school building in the state. The state guides are an effort to help districts have their curricula on file by 1989.

It is too early to know the effect of state reforms on mathematics instruction as certification rule changes become effective October 1, 1988. Minimum standards for approved schools are currently being rewritten; and the final copy of the state's Mathematics Curriculum Guide was disseminated to schools winter, 1988. One could say the state is in a period of transition.

TRENDS AND ISSUES

Iowa faces many problems in improving science instruction. First, the state's economy is suffering due to the agricultural situation; this complicates all budgetary matters, especially educational finances. Second, the reorganization of the educational system has caused some confusion about where the state is going in regard to educational matters, how it's going to get there and who is going to lead. Third, the state needs to implement an assessment program, an instrument to measure overall achievement. Last,

the "Right to Know" legislation that requires the public to be informed of the hazardous chemicals that teachers or students may come in contact with has caused much concern. All chemicals used in schools must be documented; the additional paperwork associated with this documentation is time consuming and takes away from instructional time. The intent of the legislation was good, but some of the results may hinder science instruction.

Several problems exist that also make improving mathematics instruction difficult. First, a broader mathematics curriculum needs to be taught. Second, teacher inservice programs need to be provided to help solve the first problem. Third, the state lacks adequate funding for materials and staff development.

Work has begun to address the mathematics curriculum problems, and the state is initiating teacher training sessions that focus on this issue. However, the funding problem is expected to persist and hinder most efforts at improving education.

KANSAS

CURRICULUM

Curriculum Guides

Kansas' science curriculum guides were developed by a committee of teachers, administrators, science coordinators and college representatives. Use of the guides by districts is recommended, not required. The guides exist for grades K-12 and were last revised in 1986.

The state began development of a mathematics curriculum framework in June 1987.

Higher Order Thinking Skills

Higher order thinking skills are emphasized in the curriculum guides under "science processes." Critical thinking skills are also emphasized in teacher's workshops.

Higher order thinking skills will be addressed in the mathematics guide currently being developed.

Time Requirements

Kansas recommends that students in grades K-4 receive 60 minutes per week of science instruction, that 5th through 7th graders receive 150 minutes per week in science and that students in grades 8-12 receive 250 minutes of science instruction per week. Students at the high school level must receive a minimum of 200 minutes of science instruction per week for two years to meet graduation requirements.

The state does not have time recommendations that apply to mathematics instruction except at the high school level; students must receive 200 minutes of mathematics instruction per week for two years to meet graduation requirements.

Graduation Requirements

Effective with the graduating class of 1988, two units of science and two units of mathematics are required for graduation.

STUDENTS

Recognition and Awards

Recognition programs in science are primarily left up to local and national sponsors. Kansas students participate in the Department of Energy's programs for 11th and 12th graders, the West Virginia National Youth Science Camp, the Science Olympiad (sponsored by the Kansas Association of Teachers of Science) and the Junior Academy of Science for students in grades 7-12.

Students in Kansas participate in numerous national mathematics competitions. These include the National High School Mathematics Examination, the National Junior High School Mathematics Examination, Math Counts and Math Olympiads for Elementary Schools. Participation in these competitions is at the discretion of local districts.

An average of 5,000 students in grades 4-8 participate in a statewide mathematics contest that is cosponsored by the Kansas Association of Teachers of Mathematics and the Kansas State Department of Education.

Summer Institutes, Magnet and Residential Schools

No special science or mathematics schools are reported.

Special Populations

In addition to programs supported by Title II funds, school districts will soon be able to participate in the Applied Mathematics Program that is being developed by a consortium of mathematics and vocational educators through the Center for Occupational Research and Development in Waco, Texas. The program stresses the usefulness of science and mathematics through a hands-on approach and focuses on serving the needs of underrepresented groups.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

Higher order thinking skills are not addressed in the testing program.

Assessment Content

Assessment objectives are included in state curriculum guides.

Assessment Reporting

Assessment results are reported for the state, districts, schools and students. State and district results are made public, and districts have the option of making school results public.

Assessment results are intended to be used by schools as one indicator of program effectiveness and to identify areas in which further diagnosis of student strengths and weaknesses is needed. Results are intended to be used by districts as one indicator of program effectiveness and as a source of information for curriculum planning. Results are intended to be used by state education policy makers as an indicator of statewide student achievement in selected minimum competencies in mathematics and reading.

Subjects Assessed

Students in grades 2, 4, 6, 8 and 10 are annually assessed in mathematics and reading.

TEACHERS

Teacher Recruitment and Retention

The state education agency works with districts under Title II to pay for inservice programs and extra credit materials. The state is also working to develop an Elementary Science Academy, through which teachers would be paid a stipend for attending a four-

week program. The focus will be to strengthen elementary science curriculum and instruction with special emphasis on meeting the needs of females and minority students. Methodology, curriculum and content will be emphasized during the training sessions.

The Kansas Board of Regents funded three projects at two regents' institutions and one private university for the purpose of training and retraining teachers in mathematics education. Funds for the three projects were obtained from the regents' share of Title II monies.

Teacher Shortages

A shortage of teachers in the areas of science and mathematics appears to be emerging. A recent state survey revealed that within five years, up to 25% of secondary mathematics teachers will be leaving the teaching profession.

Certification Requirements

Elementary school teachers must have knowledge in lab- or field-oriented science in each of three areas: biology, physical science and earth science. In addition, skills in methodology in teaching science, field experience in observation and tutoring, experience in planning and teaching science and experience in laboratories (including working with equipment, instruction materials and library research) are required competencies expected of incoming teachers.

Science and mathematics endorsements are available at the middle school and junior high school levels. Secondary certification to teach science requires a general science background and specific competencies in a specific area, such as biology, chemistry or physics.

Alternative Certification

Under provisional certification, an individual can teach with only a bachelor's degree while enrolled in courses to become certified. The courses must be completed within a year.

Teacher Training

The state education agency provides workshops and works with universities and colleges to upgrade the skills of science teachers in the state.

Funds are being provided through Title II to upgrade the skills of mathematics teachers. A summer institute for mathematics teachers of middle-level students is under consideration.

Staff Development Needs

Major staff development needs as identified in the 1986-87 science/mathematics survey conducted by the state are as follows:

Teacher training should better enable teachers

- to incorporate the teaching of problem-solving and thinking skills into the content areas of science and mathematics

- to employ the use of manipulatives (concrete objects) into the teaching of science and mathematics
- to use calculators and computers in the teaching of science and mathematics
- to use a variety of methods to evaluate student performance in the areas of science and mathematics
- to employ an inquiry process (a process that actively involves students in making discoveries about the nature of a discipline) in the teaching of science and mathematics
- to incorporate the use of individual projects and small group work into the teaching of science and mathematics
- to utilize library/media center and community or area resources in the teaching of science and mathematics
- to address the special needs of historically underrepresented and underserved populations in the fields of science and mathematics
- to utilize more fully a wide variety of science equipment and materials in teaching science
- to want to participate in meetings and workshops sponsored by state and national science and mathematics teachers' organizations

FUNDING

Districts are using Title II funds for inservice programs, materials, sending teachers to workshops and conferences, and for curriculum development.

RECENT STATE REFORMS/NEW INITIATIVES

The state-conducted science/mathematics survey helped to identify several major needs. The State Department of Education is currently developing a master plan to address these needs in improving science and mathematics instruction in Kansas.

TRENDS AND ISSUES

Current issues in improving science and mathematics instruction include:

1. Providing quality science and mathematics instruction to all students, especially to students that may be at risk of school failure and dropout because of factors of race, sex, location, language deficiencies, drug and alcohol abuse, and other related factors.
2. Providing the necessary training and retraining of teachers to better enable teachers to use teaching methods that are more suitable for elementary and secondary age children in promoting an understanding and literacy in the areas of science and mathematics.
3. Recruitment of personnel to replace teachers in science and mathematics who plan on leaving teaching in the next few years.
4. Providing training and designing software that will promote a more comprehensive and effective use of technology in the teaching of science and mathematics.

Current trends in science and mathematics instruction include:

1. A likelihood of more "at-risk" children failing science and mathematics courses at the secondary level.
2. A shortage of qualified teachers to teach in science and mathematics in the immediate future.
3. Delivery of more secondary science and mathematics instruction via distance learning technology.

KENTUCKY

CURRICULUM

Curriculum Guides

Kentucky has a Science Skills Continuum and a Mathematics Program of Studies that districts may use when developing their own curriculum guides. The Science Skills Continuum contains appropriate skills for grades K-10 that were identified by a state committee appointed by the State Department of Education. For each skill, several sample student activities are presented, and teachers are encouraged to expand and develop additional activities for each of the skill areas. Minor revisions to the guides will be completed in 1987.

The Mathematics Program of Studies includes objectives and skills for grades K-8 and course descriptions for grades 9-12. A state mathematics consultant, along with a committee of teachers and college personnel from around the state, developed the guides, which were revised in 1987.

Higher Order Thinking Skills

Higher order thinking skills are addressed in science through workshops, inservice programs, informal sessions with local school districts and concurrent sessions at the annual science conference. The Science Skills Continuum emphasizes process skills rather than content.

Likewise, the Mathematics Program of Studies emphasizes discovery, problem solving and hands-on activities that encourage exploration and experimentation. Individual course descriptions also address higher order thinking skills.

Time Requirements

Kentucky requires 120 minutes of science instruction per week in grades 1-4 and 225 minutes of science instruction per week for grades 5, 6, 7 and 8.

The state requires 300 minutes of mathematics instruction per week in grades 1-4 and 225 minutes for grades 5-12.

Graduation Requirements

Kentucky students graduating in 1987 are required to complete three units of mathematics and two units of science. Statutes mandate that 60% of a student's time be spent on basic skills that include science and mathematics. Local boards may award different diplomas to students who successfully complete more units than the state requires.

STUDENTS

Recognition and Awards

The State Department of Education supports the efforts of the Kentucky Association for the Progress of Science. Kentucky emphasizes National Science Week each year.

Outstanding gifted students are selected for the Duke Talent Identification Program (7th grade students are tested in science and math for entry into the program; however, it covers areas other than science and mathematics), the Kentucky Junior Academy of Science (student competition for research projects), Computer Competition and a State Math Bowl Competition. The top team in the Math Counts Competition receives four-year scholarships from the University of Louisville and the University of Kentucky.

The State Department of Education also coordinates activities for national organizations such as the West Virginia National Youth Science Camp. Many competitive events are also held, such as Odyssey of the Mind, science fairs, etc., to recognize student achievement.

Summer Institutes, Magnet and Residential Schools

The state education agency supports the magnet school concept, but these types of schools are operated and funded by local school districts. Jefferson County Public Schools in Louisville have a magnet school program in science and mathematics; Fayette County Public Schools operate a magnet program that includes science and mathematics.

Kentucky's Governor's Scholars Program is a summer institute offering special instruction in all subjects, including biology, problem solving and computers. The summer program lasts four to six weeks, with 600-650 students in attendance. Individual schools select students to attend on the basis of a process of application, test score comparisons and recommendations.

Special Populations

The state of Kentucky was one of 10 states selected to participate in the 1985 Council of Chief State School Officers' (CCSSO) Leadership Conference on Women and Minorities. The state has continued to replicate the conference the past two years. Topics covered at the conference include Equity and Excellence: A Challenge to Kentucky Education; Equity in Mathematics; Science and Computers; Teacher Expectations; The New Computer Literacy; "Reasoning for the Fourth "R"; Science is Basic; Individualizing Middle School Science; Mathematics Teacher Retraining Strategies; and Equity and Excellence in Science.

A Math/Science/Technology summer workshop in 1987 for teachers of grades 5-9 focused on equity, problem solving and integrating science and mathematics.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

The focus of Kentucky's assessment program is on "essential skills." Higher order thinking skills are of concern, and such content is measured on the CTBS/4, a shortened version of which is embedded in the state-constructed test now in use for grades K-12.

Assessment Content

Current law requires the establishment of essential skills in the five content areas measured, taught and assessed.

Assessment Reporting

Assessment results are reported for the state, for districts, schools and students. Results for the state and districts are made public.

Assessment results are intended for use by schools to monitor curriculum and student achievement, for districts to monitor curriculum and for public information, and for state policy makers to monitor curriculum, for public information and to use when reviewing programs and legislation.

Subject Areas Assessed

In 1987, all Kentucky students in grades K-12 were assessed in reading, writing, mathematics, spelling and library/research/reference skills.

TEACHERS

Teacher Recruitment and Retention

Kentucky has a loan scholarship program that began in 1982. Undergraduates in shortage areas and teachers who attend summer school to become retrained and certified in science or mathematics are eligible to apply for the scholarships. In 1985-86, $430,000 was appropriated for the program. Three hundred eighty thousand dollars of the appropriation was used for 174 scholarships; the remaining $50,000 was used for summer retraining programs. This program is now being administered by the Higher Education Assistance Authority.

Teacher Shortages

Teacher shortages are reported for both science and mathematics. In addition to the loan/scholarship program mentioned above, shortages are being addressed through the development at several universities (using Title II monies) of courses for middle school teachers in science and mathematics for recertification and/or master's programs credit.

Certification Requirements

Six hours of science credit (to include biological and physical science, both of which must include a lab component) and at least six semester hours of mathematics credit are required for certification as an elementary school teacher.

Middle school certification in science requires 24 semester hours of course work (specifically, nine semester hours each of a selection of earth science, chemistry or physics and the remaining six hours to be divided equally among the two remaining disciplines, with lab experience required in all). Middle/junior high school certification in mathematics requires a minimum of 24 credit hours of course work.

Secondary certification in science requires a minor (21 hours) or major (30 hours) in science but states that a minor cannot be listed on the certificate unless there is a major in one of the other sciences or a major in mathematics. Secondary certification in mathematics requires a minor (21 hours) or major (30 hours) in mathematics.

In 1986-87, a teacher internship program was initiated in Kentucky. The intern is paired with a "master" teacher for one year and is paid a first-year teacher's salary. A committee of one administrator, one teacher and one college representative evaluates the intern.

Alternative Certification

The State Board of Education enacted a regulation that provides for the emergency certification of qualified persons. The State Superintendent of Public Instruction issues emergency certificates after assessing the need for additional personnel expressed by a local school district. (Local districts may express such a need only after having conducted an extensive search for a regularly certified teacher.) Applicants must have a minimum GPA of 2.0 on a 4.0 scale and at least 64 semester hours of college credit.

Individuals with at least a bachelor's degree, an overall GPA of 2.5 and occupational experience in the appropriate subject area may be hired as "adjunct instructors" if there is a critical teacher shortage.

Teacher Training

The State Department of Education is working to upgrade the skills of science teachers through Title II funded regional workshops with colleges and universities and the summer institute for science and mathematics teachers, and by providing the services of a consulting physical science resource teacher who works directly in the schools.

To upgrade the skills of mathematics teachers, the state education agency has developed the new Mathematics Program of Studies and has scheduled inservice programs to explain and encourage its use. The state education agency also encourages inservice programs in teacher's subject areas, and conferences, workshops, etc., are sponsored by both the state education agency and the Kentucky Council of Teachers of Mathematics.

Staff Development Needs

The greatest staff development needs among science teachers are to upgrade content knowledge in specific topics, to assist with reasoning skills and problem solving and to learn new teaching techniques and styles.

The greatest needs among mathematics teachers are problem solving, use of calculators, use of computers as a mathematics tool, use of manipulatives as opposed to drill and workbooks and estimation activities.

FUNDING

Title II funds are used to produce or send teachers to workshops (e.g., the National SSMA conference), to assist local staff development efforts, to buy computers and science and mathematics software, to support teachers attending summer school for course work and for programs that provide a full-time science teacher with leave for one year to aid other teachers.

Title II funds are also supporting the new Science Improvement Project for physical science at the secondary level (grades 7-12). The state has hired an outstanding physics teacher to serve as a consultant to schools within the 5th and 7th Congressional Districts. These districts were chosen because of a lack of funding and low achievement

scores. The consultant will demonstrate to physics teachers in these districts how to teach science, how to use math in teaching science and how to integrate computers into science instruction.

RECENT STATE REFORMS/NEW INITIATIVES

A wide variety of reforms and initiatives are under way in Kentucky. The Kentucky Essential Skills must be taught and assessed at each grade level and the new Program of Studies, which identifies a curricular framework for schools in the state, has been developed. Teachers are required by the new middle school certificate to be more fully credentialed in science and mathematics at the middle grade levels. The Commonwealth Diploma requires high school students to take four years of mathematics and three years of science. The number of newly certified science teachers has increased because of the Incentive Loan Program, and a major effort to place teachers in-field is being coordinated through the State Accrediting Program.

TRENDS AND ISSUES

The three biggest problems in science instruction are:

1. No equipment and materials for elementary science instruction;
2. Out-of-field teachers at the middle school level and in physical sciences at the high school level; and
3. Inability of elementary teachers to offer and teach a coordinated science program.

The three biggest trends in mathematics instruction are:

1. Getting teachers away from using a drill-and-practice mode into using a problem-solving mode using manipulatives, calculators, etc.;
2. Trying to encourage teachers to teach skills above and beyond those mandated in the Kentucky Essential Skills; and
3. Lack of money to provide more inservice programs for teachers, including materials, training, etc.

LOUISIANA

Louisiana did not provide answers to the specific survey questions related to mathematics curricula.

CURRICULUM

Curriculum Guides

Louisiana's K-12 science curriculum guidelines and education standards were initiated in 1976 by a task force consisting mainly of classroom teachers. Use of the guidelines and standards is required. They were last revised in 1984. Individual guides are available for every subject; for example, biology (grades 9 and 10), life science (7th grade), earth science (grades 8 and 9), etc.

Higher Order Thinking Skills

The revised curriculum guides emphasize higher order thinking skills; process skill areas in science are emphasized on the 11th grade graduation test. (Note: This test is being piloted during the 1987-88 school year.)

Time Requirements

Students in grades 1-4 receive a recommended 45 minutes per day of science instruction. The state recommends that students in grades 5, 6, 7 and 8 have 55 minutes of science instruction. (Ten percent of the 5th grade classes and 15% of 6th grade classes exceed these guidelines.) High school students are required to take two to three Carnegie units of science.

Graduation Requirements

Graduation requirements in Louisiana for science and mathematics are three Carnegie units each. Beginning in 1989, students must pass the Eleventh Grade Test to graduate. This criteria is required by the Louisiana Competency-Based Education Program implemented by the Department of Education.

STUDENTS

Recognition and Awards

Science recognition programs include a Science and Humanities Symposium for 10th to 12th grade students at Louisiana State University. Students present science research papers in front of college faculty, and outstanding students receive scholarships.

The Louisiana High School Rally is for high school students in all academic subjects. Students are tested, and students scoring the highest in the rally receive scholarship to attend state colleges and universities.

The Science Olympiad (for grades 8-12), sponsored by Loyola University, Tulane University and local school districts, offers rewards to individual students and schools as well as opportunities to compete at the national level.

Two State Science Fairs (for grades 8-12) are sponsored by the Louisiana Academy of Science, Louisiana State University and the Louisiana Department of Education. The awards vary; some include cash or scholarships. Ten regional fairs are also organized under the state fair program. All are affiliated with the International Science and Engineering Fair.

Louisiana students participate in the U.S. Department of Energy programs and receive trips to Livermore and Brookhaven to work at research labs. In addition, students participate in the West Virginia National Youth Science Camp.

Summer Institutes, Magnet and Residential Schools

The state-supported Louisiana School for Mathematics, Science and the Arts is located in Natchitoches on the Northwestern State University campus. The school is patterned after the North Carolina School for Science and Mathematics and accommodates 700 11th and 12th grade students. The first class, composed of talented students nominated by school systems, entered in September 1983. A full curriculum in computer education is offered.

Universities offer summer programs through their continuing education programs for talented students (from middle school through 12th grade). All of the state's magnet schools offer joint courses with universities (students can be enrolled in universities and high schools simultaneously). There are many special programs within comprehensive high schools for gifted students.

Special Populations

Several magnet schools in Louisiana focus on recruiting minorities. Vocational education is closely tied with science career programs (i.e., medical technology) that aim at serving underrepresented populations. A lot of the state special education programs for gifted and handicapped students (part or full time) focus on science, mathematics and computers.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

Within the context of the state curriculum standards, measurement of certain standards requires students to use higher order thinking skills. The newly developed 11th grade test in science emphasizes the application of knowledge and process skills.

Assessment Content

Assessment content is strictly aligned with state curriculum guides and objectives. Louisiana has curriculum guides and objectives for all required courses (K-12).

Assessment Reporting

Assessment results are reported for the state, districts, schools and students. State and district results are made public; school results are available at the discretion of the local education agencies.

Assessment results (for grades 3, 5 and 7) are intended to be used by schools and districts for instructional planning, compensatory and remedial education and as a principal criteria in student promotion decisions. For grade 11, results are used as a graduation requirements and for remediation. (Note, however, that a date to enforce the graduation requirement has not yet been established.)

Results are intended for use by education policy makers to provide longitudinal data on the status of student performance, to provide data for state-level program planning and for policy decisions such as fiscal allocation and measuring education improvement.

Subjects Assessed

Students are assessed annually at grades 3, 5, 7 and 11 in mathematics, reading, writing, and language arts. Eleventh graders are also tested in social studies and science.

TEACHERS

Teacher Recruitment and Retention

No recent initiatives to attract or retain teachers were reported.

Teacher Shortages

Louisiana has a shortage of science teachers and is addressing it by using Title II monies at the college level to retrain teachers in science and mathematics by training individuals from business and industry and by developing new courses that can be taught by the most populated teacher certification areas which enables the student load to be shifted around.

Certification Requirements

Elementary school certification requirements include 12 semester hours in science and six semester hours in mathematics. For secondary school certification, general education requirements are the same as for elementary certification. Additional specialized education for secondary certification includes 20 semester hours in mathematics (including one semester each of calculus and college geometry), 32 in general science (including eight each in biology, chemistry, earth science and physics), 20 in biology (including botany, zoology and microbiology), 20 in chemistry, 20 in earth science and 20 in physics. General science certification is synonymous with physical science. A person certified in biology can also teach environmental science (the state will eventually offer a special certification for environmental science).

Three levels of certification are offered — A, B and C. Teachers receive C-level certification with the completion of program and passage of the National Teachers Examination. This certificate is valid for three years before the teacher must apply for B certification. The B certificate is a lifetime certification; however, holders must complete six credits of course work every five years. After five years of teaching and receipt of a master's degree, teachers can receive the A certificate, but will still be required to take continuing education courses.

Alternative Certification

People holding a bachelor's degree and having passing scores on the NTE may enter an internship program (developed through an institution of higher education) and receive provisional certification.

Teacher Training

The state education agency is upgrading the skills of science teachers in the state in a number of ways. It provides inservice training for use with the mandated curriculum; supports and encourages the development of consortia aimed at using Title II funding for seminars, workshops and special programs to enhance science teachers' skills; and encourages the development of networks and teacher associations, for example, the Louisiana Teachers' Association.

Staff Development Needs

The greatest staff development needs among science teachers are:

1. Need for motivation sessions and for greater interaction among science teachers to promote the exchange of ideas;
2. Professional upgrading meetings are needed in which teachers learn about innovations in the field of science; and
3. Elementary/middle school teachers need more methods demonstrations so they may be exposed to more ways of teaching science.

FUNDING

Districts are pooling their Title II funds with other districts to fund joint workshops and individual district workshops and to bring in consultants as well as substitutes that enable teachers to attend meetings.

Additional state funds targeted to science instruction have been made available to districts. For example, the state funds consortia (based on review of proposals) and funds a science instruction program at Louisiana State University's Sea Grant College aimed at marine education and coastal awareness.

RECENT STATE REFORMS/NEW INITIATIVES

Recent initiatives that have promoted science in Louisiana are a request that nuclear education be taught in the science or social studies curriculum and the new 11th grade exit test that will include science.

TRENDS AND ISSUES

The biggest problems Lousiana faces in improving science instruction are:

1. Public awareness of the importance of science instruction at the elementary and middle school levels and of how science affects economics. (The state education agency is trying to promote awareness by collecting data on where the problems are, which is to be shared with leadership and the general public.)

2. Financial support is lacking. (The state education agency is attempting to develop legislation to promote science education.)
3. Rewards for teaching science are limited and need to be addressed. (The state education agency is promoting legislative mandates that place science or environmental education on the agenda.)
4. No funds are available for equipment and instructional materials.
5. Leadership continues to stress basic skills, underserved populations and special education, which are all important yet do not bridge the gap with content areas.
6. Teachers with elementary certificates are teaching specific subject areas in science at the middle school level in which they have limited training.

MAINE

CURRICULUM

Curriculum Guides

Maine does not have mandated or recommended curriculum guides or learner outcomes.

Higher Order Thinking Skills

The Maine Department of Education, through Title II funds, sponsors an annual problem-solving conference for science and mathematics teachers. The conference is in its second year. In addition, higher order thinking skills are included in the Maine Educational Assessment, thus making these skills a curriculum area.

Time Requirements

The state recommends that students in grades 1-3 receive 90 minutes of science instruction per week. One hundred fifty minutes per week are recommended for grades 4-6; 200 minutes per week are recommended for grades 7-12.

There are no time recommendations or requirements per se for mathematics; however, sequential instruction is required. Such instruction must include mathematics concepts, the metric system, computation, measurement and problem solving.

Graduation Requirements

In Maine, effective with the graduating class of 1988, students must complete two credits of science, including one credit of laboratory study and two credits of mathematics. ("Laboratory study" means a course in which at least 40% of the instructional time is directed to the student's application of the principles of science.) In the case of hardship, the State Department of Education may grant waivers to vocational education students, allowing them to satisfy the second-year mathematics requirement through separate or integrated study as part of the vocational curriculum. Further exception to the rule is provided for students who are excused and for students such as truants and dropouts. Up to one-fourth of the credits received by these students may be earned in alternative education programs (tutoring, adult education and correspondence courses, etc.). High school equivalency diplomas may be issued to adults or 17-year-olds with documented need and local superintendent's approval.

STUDENTS

Recognition and Awards

The Maine Secondary School Principals Association sponsors the State Science Fair for students in grades 10-12. Students in grades 11 and 12 may participate in the U. S. Department of Energy Summer Programs and the West Virginia National Youth Science Camp.

The state's mathematics teachers sponsor the Piecone Math League for high school students. Several regional competitions are held throughout the year. Teams receive points that accumulate and are totaled at the end of each year. Top scoring teams

receive trophies. There is also a state competition, a one-day event in which all teams participate. Team and individual achievement is recognized.

The state engineering society sponsors statewide Math Counts competitions for 7th and 8th grade students. Regional competitions are held throughout the state. The top three teams from each region participate in the state-level competition where the top team is identified. The four highest scoring individuals earn a trip to Washington, D. C., where they participate in the national Math Counts competition.

Additional recognition programs for outstanding mathematics students include the Southern Maine Math League for grades 7-12, the Southern Maine State Meet for grades 5-9, the 5th and 6th Grade Math Meet and a Domino's Competition, sponsored by Domino's Pizza.

Summer Institutes, Magnet and Residential Schools

The state does not support special schools, such as magnet or residential schools, for students studying science or mathematics. However, some of the state's colleges sponsor three-week summer institutes for high school students. Approximately 30 students are selected through processes arranged by the sponsoring institutes. Course offerings include life science, physical science and earth and space science.

Special Populations

The Maine Occupational Information Coordinating Committee sponsors sessions for students and teachers on careers for women. In addition, Title II Higher Education Projects address the needs of special populations in an effort to increase their participation in science and mathematics.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

Maine is addressing higher order thinking skills in its statewide assessment through items measuring the range of cognitive levels. The items are both multiple choice and open response. Specific higher order thinking skills assessed include measurement, problem solving, process and inquiry.

Assessment Content

The content of the Maine Educational Assessment (MEA) is determined by subject-level committees of teachers and specialists from institutions of higher education.

Assessment Reporting

The state reports assessment results for students, schools and districts. Results for districts and schools are made public.

MEA results are used in the development of school improvement plans by schools and districts. Results are routinely shared with the Bureau of Instruction and Vocational Education for consideration in planning services. The State Summary Report with a special briefing is made available to legislators on the Legislator's Joint Committee on Education.

Subject Areas Assessed

During the 1987 school year, all students in grades 4, 8 and 11 as well as a matrix sampling of students in grades 4, 8 and 11, will be tested in reading, writing, mathematics, science, social studies and humanities. The same assessment schedule will be followed during the 1988, 1989 and 1990 school years.

TEACHERS

Teacher Recruitment and Retention

No recent initiatives have been implemented by the state to attract or retain science or mathematics teachers. The minimum salary of all teachers was increased by mandate; however, the state subsidy was not increased.

The city of Portland funds a retraining program held at Long Island University. Teachers of subject areas other than mathematics are retrained to teach mathematics.

Teacher Shortages

Maine is experiencing teacher shortages in science and mathematics. However, the state is presently undergoing a transition with a new governor and commissioner, and no new directions have been taken to solve these problems.

Certification Requirements

For an elementary certificate (K-8), no science or mathematics training is required. For a secondary certificate (7-12), one must have a 30-hour major and/or an 18-hour minor in the subject to be taught. No certification is available solely at the middle grade level. Maine does not require a fifth year of professional education for certification.

Alternative Certification

Conditional certificates are available to qualified people following a transcript analysis and completion of six hours of educational course work. Additional course work may be recommended.

Approximately 500 people per year take advantage of this certification route. In secondary science, approximately 40 people per year use this route. Seventy-five percent of the 500 people that receive conditional certificates are already certified in one area and use this alternate route to change teaching areas.

Teacher Training

The state has put a great deal of energy into upgrading the skills of science and mathematics teachers by encouraging and supporting the development of training workshops. A PRISM Conference (Problem Solving in Science and Mathematics) was developed and is held annually. Districts are being encouraged to develop a plan of action for inservice programs funded by Title II.

Staff Development Needs

The greatest staff development need among the state's science teachers is communication/coordination ranging from kindergarten through grade 12.

Mathematics teachers' needs include the use of manipulatives, the integration of calculators and computers, teaching applications or discrete mathematics and teaching problem solving.

FUNDING

Generally, districts use Title II funds to increase teacher skills through inservice programs. For example, "Math Their Way" training is popular, as are workshops on physical science for elementary teachers. Funds are also used to send teachers to professional conferences. The state does not allow districts to ask for waivers that would allow Title II funds to be used in ways not specified in the Education for Economic Security Act.

RECENT STATE REFORMS/NEW INITIATIVES

The Education Reform Act of 1984 has had a strong impact on science and mathematics instruction, mostly through increased graduation requirements, a written curriculum mandate and statewide assessments.

TRENDS AND ISSUES

To improve science instruction, the state must reduce the anxiety of teaching science experienced by many elementary teachers, reduce teachers' reluctance to implement reforms (most teachers have seen reforms come and go) and increase the funds available to implement mandates.

The size of the state and its geography also cause problems. While the majority of Maine's population is south of Augusta, there are isolated pockets of large populations scattered throughout the state. Most do not have access to universities and other teacher training services.

Mathematics teachers have few role models on which to draw, and few professional people to offer workshops.

MARYLAND

CURRICULUM

Curriculum Guides

In 1983, a statewide committee of supervisors, teachers and higher education representatives developed Maryland's course framework for grades K-12 in the areas of English, language arts, mathematics, social studies, physical education, fine arts and science. The frameworks are required for district use by law.

Higher Order Thinking Skills

Numerous workshops and state conferences have been conducted on higher order thinking skills in all subject areas, especially science and mathematics. Curriculum development and implementation grants have been awarded to districts that emphasize higher order thinking skills. State level policy makers and state assessment staff are collaborating in developing guidelines for tests at the classroom, school and district levels.

Time Requirements

There are no time requirements for science or higher order thinking skills. Two Carnegie units are required in science at the secondary level.

Graduation Requirements

State board regulations in Maryland require two years of science and two years of mathematics. For the graduating class of 1989, an additional unit of mathematics will be required. A computer studies course, if selected, would be a one-credit elective. Students are required to pass a competency test first administered in grade 9 in mathematics, reading, writing and citizenship to receive a diploma. Students may retake the test and enroll in appropriate assistance programs leading to certification for graduation. Persons 16-years-old and older who have been out of school (three months of longer) may receive a diploma upon passage of a state-designed test. No changes in these requirements are being proposed.

STUDENTS

Recognition and Awards

Numerous local and regional science fairs are held annually; winners are eligible to attend the International Science Fair. Maryland students also participate in the West Virginia National Youth Science Camp. During the summer of 1987, numerous students will attend the U.S. Department of Energy seminars.

There are no special award programs specifically for students studying mathematics.

Summer Institutes, Magnet and Residential Schools

The state education agency supports numerous one- and two-week summer institutes for gifted students (grades 5-12) that are held on college and university campuses, at science museums and at other institutions around state. Applicants are screened by selection

committees on the basis of an achievement test, teacher recommendations and an essay describing special training, honors and interests. Courses offered include aquatic biology, environmental science, problem solving, computer programming, computer-oriented mathematics, advanced topics in mathematics, physics, energy, optics — and even a space science course taught at NASA. The state education agency pays at least 50% of the costs; parents pay a registration fee as well as some room-and-board expenses for the residential two-week courses.

Special Populations

Title II pass-through funds must take into consideration the special needs of the underserved and underrepresented. In 1988, the state education agency will conduct a statewide conference introducing exemplary programs for special groups. Grants for implementation will be offered.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

Higher order thinking skills are not directly assessed by the Maryland Functional Testing Program. While currently there is no supportive research, it is believed that the Maryland Writing Test and some domains of the other functional tests do approach measurement of higher order thinking skills. This is a performance objective for next year (1987-88).

Assessment Content

All schools are required to teach the "functional" skills contained in the state board endorsed competencies index. This index provides the basis for the objectives assessed by the state tests as well as the test specifications. Items are field tested, analyzed and revised prior to being included in the item bank. Staff from the Division of Instruction and Project Basic of the Maryland Department of Education produced instructional guides for each subject area. These documents summarize the content domains and objectives covered by each test. They were also designed to help teachers develop instructional activities to prepare students for the tests. Instructional guides were distributed statewide.

Assessment Reporting

Assessment results are reported for the state, districts, schools and students. Maryland Department of Education reports only state pass-rates. Districts determine whether or not to make public district and school pass-rates.

Tests are intended to be used by schools to certify that students have mastered skills in the four basic areas of reading, mathematics, citizenship and writing. If deficiencies are found, students receive remedial instruction to enable them to reach mastery prior to high school graduation. For districts, the purpose of the testing program is to measure, disclose, interpret and improve results achieved by public school education programs. Districts should look at their school results, analyze settings, programs and processes and improve their educational system. State education policy makers should use assessment results to support the districts in their planning and implementation of improved educational programs.

Subject Areas Assessed

At this time, Maryland's testing program is expected to be continued indefinitely. Every year, all students in grades 3, 5 and 8 are tested in mathematics, reading and language arts. All students in grade 7 are tested in mathematics, reading and writing annually; all students in grade 9 are tested in mathematics, reading, writing and citizenship. Students must pass these tests to graduate. The 9th grade test may be retaken in grades 10, 11 and 12 if necessary.

TEACHERS

Teacher Recruitment and Retention

Maryland's scholarship program provides up to $4,800 per year to science and mathematics undergraduates. Sixty students received scholarships totaling $142,000.00 through this program in 1985-83.

Teacher Shortages

Maryland currently has a shortage of science teachers and a shortage of mathematics teachers in some geographical areas.

The Department of Education recently received a Secretary's Discretionary Grant for the Retiree Outreach Project — a program to promote a second career in teaching science and mathematics for retirees from business and industry.

Certification Requirements

Elementary certification requires a bachelor's degree except in trade and industry areas. Secondary certification requires 24 semester hours in mathematics, 24 semester hours each in biology, chemistry, earth science and physics or 36 in secondary school general science, including 18 in one specialty area and six each in two other science areas, or a graduate of an approved program without transcript analysis. The National Teachers Examination is also a requirement for certification. There is no permanent certification; however, the initial five-year certificate (a Standard Professional Certificate) can be renewed for an additional five years. After receiving two Standard Professional Certificates an individual is eligible to receive an Advanced Professional Certificate. The Advanced Professional Certificate is based upon a master's degree or a master's equivalency and verification of three years of appropriate experience.

Alternative Certification

An individual who has a bachelor's degree and has not met certification requirements may be issued a Professional Degree Certificate if no certificated teacher is available. The Provisional Degree Certification requires that the individual complete six semester hours of course work per year until the requirements are met. Trades and industry people are not required to present a bachelor's degree. Information is not available on the number of people who have taken advantage of this certification requirement.

Teacher Training

Title II funds have provided numerous training and retraining opportunities. The state education agency has offered conferences in elementary science, science technology and

society, probability and statistics; new this year are science, statistics and communication. All conferences were followed by grant awards for curriculum development and implementation. Curriculum projects in earth science and genetics have also been funded.

Inservices on mathematics content and strategies are offered at the state level. Workshops are held by state staff on request at the local level.

Staff Development Needs

In terms of staff development, middle school teachers who have moved up from the elementary level need more science course work for certification. Concerning mathematics, elementary and middle school teachers need to increase their content knowledge; senior high mathematics teachers need to update their instructional strategies.

FUNDING

Through Title II funds, teacher training, retraining and inservice programs are offered in the areas of science, mathematics and foreign language. Staff members from districts may participate along with personnel from private schools. Funds spent on instructional materials and supplies are limited to those needed for conferences. Furthermore, state Title II funds are used for information dissemination to districts, technical assistance to districts and assessment of district needs.

Most districts divide Title II funds evenly for science and mathematics. District projects include offering college and university course work to upgrade content and teaching skills, inservice training for elementary teachers in the area of hands-on science, inservice training for elementary mathematics teachers in the use of manipulatives, teacher training in science technology and society, critical thinking strategies in science and mathematics, probability and statistics, convention attendance costs, computer workshops and outdoor education workshops for elementary and secondary science teachers.

No additional state monies have been allocated to improve science or mathematics instruction.

RECENT STATE REFORMS/NEW INITIATIVES

There have been no recent state reforms that have affected science or mathematics instruction.

TRENDS AND ISSUES

The biggest problems Maryland must solve to improve science instruction include upgrading elementary and middle school science and including human genetics in the life sciences and biology curricula.

The biggest problems the state faces in improving mathematics instruction include lack of content knowledge by middle school teachers, instruction at the elementary level in mathematics by teachers with the minimum mathematics credits required for certification (six) and utilization of out-of-field teachers at the senior high level.

All of these problems are perceived as such by state education policy makers and solutions are being sought.

MASSACHUSETTS

CURRICULUM

Curriculum Guides

Massachusetts does not have state mandated or recommended curriculum guides.

Higher Order Thinking Skills

There has not been a major statewide effort in Massachusetts to emphasize the teaching of higher order thinking skills except in some gifted and talented programs.

Time Requirements

The state does not provide guidelines on the amount of time to spent on science or mathematics instruction.

Graduation Requirements

High school graduation requirements are determined at the district level. College admission standards prescribed by the Board of Regents influence what districts recommend or require of their students for graduation.

STUDENTS

Recognition and Awards

The Boston Globe sponsors a science fair annually; this is the only recognition program for students at the state level. However, the state participates in several national student recognition programs.

Summer Institutes, Magnet and Residential Schools

The state does not support any magnet or residential schools or summer institutes for students studying science or mathematics.

Special Populations

A federally funded sex equity program and a state funded desegregation program both encourage and support local efforts to increase the participation of underrepresented groups in science and mathematics.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

Higher order thinking skills are incorporated in the state assessment's content areas.

Assessment Content

State committees decide upon assessment objectives that are sent to each school system for matching in regard to their curricula; the assessment objectives are modified to match local curricula if necessary.

Assessment Reporting

Assessment results are reported for the state, districts and schools. These results are made public.

Schools and districts use assessment results for curriculum improvement. State education policy makers use assessment results to identify schools in need of state aid, to determine the effects of legislation and for accountability purposes.

Subject Areas Assessed

In 1988 and 1990, all students in grades 4, 8 and 12 will be tested in reading, mathematics, science and social studies. Other subject areas may be added in 1990.

TEACHERS

Teacher Recruitment and Retention

The Massachusetts Teacher Incentive Program, available to undergraduates interested in teaching science or mathematics, provides up to $1,000 per year for up to two years in a public institution and $2,000 per year for up to two years in a private institution. One year of loan is forgiven for every year of teaching.

Teacher Shortages

Massachusetts has teacher shortages in science and mathematics, but they are not critical. In an effort to fully understand the scope of the problem, a major supply and demand study was conducted; the results indicate increased shortages at the secondary level beginning in 1991-92.

Two new successful teacher education programs have been approved by the State Department of Education — one at the University of Massachusetts and one at Harvard. Both programs should help alleviate the teacher shortage problem by increasing the supply of certified teachers. Recruiting efforts in critical shortage areas are also being planned by the state department.

Certification Requirements

Elementary certification requirements are not stated in terms of semester hours but in terms of competency. Science and mathematics are two of the "common branch" subjects in which teachers must demonstrate competence. Middle school generalist certification requirements are the same as elementary certification requirements in this respect. Middle school specialist certification requirements are the same as secondary certification requirements — a major (30-36 semester hours) in the subject to be taught.

Massachusetts does not require a fifth year of professional study beyond the initial four years to become certified.

Alternative Certification

Beginning in the summer of 1987, persons may be hired for a maximum of two years if they have at least a bachelor's degree and have completed the subject matter requirements in the subject area to be taught.

Teacher Training

The state supports a successful inservice education effort, The Commonwealth Inservice Institute, which provides funds for teacher-planned and teacher-controlled inservice programs. Many of these programs focus on science and mathematics.

Staff Development Needs

The greatest staff development needs among the state's science and mathematics teachers have not been assessed.

FUNDING

Seventy percent of Massachusett's Title II funds were distributed to districts according to the mandated formula. Teacher inservice workshops in science, mathematics, foreign language and computer education have been conducted, and programs to increase the participation of underserved groups in these subject areas have been developed.

State monies made available to districts targeted to mathematics instruction include remedial grants (K-9) and gifted and talented grants (K-12).

RECENT STATE REFORMS/NEW INITIATIVES

There have been no recent state reforms targeted at science or mathematics instruction.

TRENDS AND ISSUES

Teacher recruitment and retention are areas of concern for state education officials. Many small schools depend on two to three science teachers, and many of these teachers are close to retirement. The lack of staff and funding for school/business partnerships is another problem. The state department strongly supports these partnerships but cannot provide needed financial assistance. Elementary science is yet another problem area because elementary teachers lack the necessary science background. That there are no current initiatives to upgrade the science skills of elementary teachers compounds this problem.

MICHIGAN

CURRICULUM

Curriculum Guides

In 1985, Michigan state education agency staff (with input from field representatives) developed science performance objectives, also known as essential skills, for grades K-8. (Computer education objectives are currently being developed.) The objectives were tested in the state assessment at grades 4, 7 and 10. The use of the science objectives is recommended in local district curriculum development, and the state education agency is in the process of extending the scope of the objectives to include high school.
In 1980, Essential Goals and Objectives in Mathematics (K-9) were developed under contract by the Michigan Council of Teachers of Mathematics. These objectives are currently being revised and scheduled to be complete in fall 1987.

Higher Order Thinking Skills

There is a general effort to emphasize higher order thinking skills, and many districts are involved in training activities for all teachers. In science, the state education agency is continuing to emphasize process and science, technology and society, stressing application. Some curriculum projects have been funded by Title II funds.

The new objectives for mathematics have specifically been written to emphasize higher order thinking skills, such as conceptualization, mental arithmetic and problem solving.

Time Requirements

The Michigan K-12 Program Standards of Quality recommends that the following percentages of classroom time be allocated for science:

- Grades K-3 — 6%
- Grades 4-6 — 9%
- Grades 7-8 — 15%

These standards also recommend that 15% of classroom time be allocated to mathematics in grades K-12.

Graduation Requirements

Michigan school districts have the responsibility to determine courses of study for high school graduation. The state, however, has influenced graduation requirements by providing financial incentives to districts that adopt its recommended course requirements. Recommended guidelines are two units of science, two units of mathematics and one semester of computer education.

STUDENTS

Recognition and Awards

Michigan Science Teachers Association (MSTA) offers a student award program to recognize outstanding interest and achievement in science to schools with an MSTA

membership. Students from the state also participate in Science Olympiad, National Youth Science Camps, local science fairs and national awards programs.

The Michigan Council of Teachers of Mathematics sponsors a middle school competition and the Michigan Mathematics Association sponsors a high school competition in which students receive recognition for outstanding work in mathematics. Students from the state also participate in a number of local, regional, state and national programs, fairs and competitions.

Summer Institutes, Magnet and Residential Schools

Michigan state colleges and school districts have developed and offer several summer enrichment programs for gifted students in computers, mathematics and science. Some of Michigan's larger school districts have magnet schools with mathematics and science components. The state board of education cosponsors with selected universities a two-week summer institute for the arts and sciences for talented high school students.

Special Populations

The above recognition and enrichment programs are designed to encourage recruitment of special populations. The state education agency is developing a policy on Equity in Mathematics and Science that will target women, minorities and handicapped students. Several Title II grants have gone to districts with a focus on special populations.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

Higher order thinking skills are being defined. Specific assessment plans are uncertain, but the current philosophy suggests they will be incorporated into the content assessments.

Assessment Content

Michigan tests the sections of the state objectives deemed most important by the state education agency subject matter person and his/her advisors.

Assessment Reporting

Assessment results are reported for the state, for districts, schools and students. Results for the state, districts and schools are made public, but information on an individual student's results is not made public and is available only to the parent or guardian.

Assessment results are intended to help schools and districts determine which individual students require remedial instruction, to help schools review their programs in areas tested (e.g., grade 4 results are used to review grades 1-3 programs), and for reporting to parents on their child's progress. The district also reports to the School Board and to the public.

Assessment results are intended for use by state education policy makers in making decisions about funding a state compensatory education program, in directing resources to priority areas, for educational research (effective schools and change processes) and for developing state policy and curriculum initiatives in areas of greatest need.

Subjects Assessed

Students in grades 4, 7 and 10 are assessed annually in mathematics and reading. Other subject areas are assessed periodically on a sample basis; science was assessed for every pupil in 1986.

TEACHERS

Teacher Recruitment and Retention

Opportunities for staff development are increasingly available, and the state education agency is planning to establish Science Improvement Centers and hopes to encourage graduate assistantships. No special recruitment programs are currently in place, but attempts are made to develop more support for science education.

The State Board of Education has recognized the need for qualified teachers of mathematics. As a result, teacher training institutions have initiated programs to attract mathematics teachers.

Teacher Shortages

Some science teacher shortages are reported in a few districts. These are addressed through reassigning staff and hiring part-time teachers.

There is no shortage in Michigan of mathematics teachers who meet minimal certification requirements. However, there may be a shortage of certified mathematics teachers with extensive training in higher mathematics.

Certification Requirements

Currently, requirements for elementary certification are established by each teacher training institution. A middle school endorsement is available but not required. The endorsement requires 18 semester hours of course work in the subject to be taught. Under new rules, effective in 1988, a middle school endorsement will require a minor (20 semester hours) in a subject area. State requirements specify that people must have at least a minor in the subject area to teach at the secondary level. For example, a general science endorsement requires 24 semester hours in a wide variety of science courses. Endorsement in chemistry, biology, physics and earth science require 20 hours of course work in the specific subject area and four semester hours in any other science area.

For teacher certification, the state does not require a fifth year of professional education after the initial four years.

Alternative Certification

The state does not offer an alternate route to certification.

Teacher Training

To upgrade the skills of science teachers, the state education agency offers regional awareness workshops on a variety of topics and administers Title II funds. Ninety percent of the districts participate.

Monies have been allocated through legislation for professional development. Both formula and competitive grants are issued for upgrading the skills of mathematics teachers.

Staff Development Needs

The greatest staff development needs among science teachers are updating content knowledge, learning and using effective teaching strategies, especially for hard-to-reach students, and sharing ideas with each other.

The greatest need among mathematics teachers is training in effective instruction methods. Curriculum is currently being written that would support such instruction.

FUNDING

Districts use Title II funds for conference fees, special district-planned inservice programs, teacher participation in university courses and special workshops designed for local and regional staff, university consortium training sessions and special curriculum projects.

Additional state monies targeted to science and mathematics include professional development funds (Section 97 and 98), which can be used to improve science and mathematics. New funds may be forthcoming.

RECENT STATE REFORMS/NEW INITIATIVES

Recent initiatives include a state-administered all-pupil science assessment in grades 4, 7 and 10 in fall 1986. The low results statewide have caused a lot of curriculum review activity in schools. The state education agency has developed long- and short-range plans to improve science education.

The recent efforts by the State Department of Education and the Michigan Council of Teachers of Mathematics in revising the state mathematics objectives have led to a great deal of dialogue and district preparation for inservice programs.

TRENDS AND ISSUES

The three biggest problems Michigan faces in improving science instruction are:

1. Upgrading staff in instructional content and techniques, especially at the elementary and middle school levels;
2. Providing support staff and other resources in regions and local districts to help in improvement efforts; and
3. Designing curriculum that will to prepare Michigan students for the future.

The three biggest problems the state faces in improving mathematics instruction are:

1. Upgrading staff in instructional techniques and content, especially at the elementary and middle school levels;
2. Providing support staff and other resources in regions and local districts to help in improvement efforts; and
3. Designing a more effective mathematics curriculum.

MINNESOTA

CURRICULUM

Curriculum Guides

Statewide committees of teachers, higher education instructors and state department consultants are currently developing K-12 learner outcomes in science, mathematics, social studies and world languages. The learner outcomes will be recommended for local curriculum committees to use in the development of their own unique documents. Other subject areas are scheduled to be included in the future.

Higher Order Thinking Skills

Grants from Cray Research and the Minnesota High Technology Council are being used by the Department of Education to define higher order thinking skills and to implement curriculum models that emphasize higher order thinking skills. Districts are expected to include applications outcomes in their revised learner outcomes documents.

Time Requirements

There are state requirements regarding the amount of time spent on science and mathematics instruction. For grades 1-6, one-third of the school day must be divided between science, social studies, physical education and health. Another one-third of the day must be divided between mathematics, art and music. In junior high schools (grades 7-9), 240 clock hours of science per week are required and 360 clock hours of mathematics are required. Where 9th grade is included in a four year high school, it is recommended that 9th grade students receive at least 120 clock hours per year of science and mathematics instruction. This recommendation also applies to grades 10-12.

Graduation Requirements

Early graduation is allowed in Minnesota for those who finish the required units before their scheduled graduation date. Since 1982, the established minimum requirements for science and mathematics is one unit each. Currently, the state board is discussing the idea of eliminating the minimum state graduation requirements and making them the sole responsibility of local education agencies in the form of established learner outcomes. Students entering the 11th grade may, at their own discretion, elect to attend an institution of higher learning part time or full time. It is possible for students to receive their first two years of college gratis. The state board is also considering waiving graduation rules and requiring some form of outcome-based education and open-enrollment for students.

STUDENTS

Recognition and Awards

The main recognition programs for students in science include the Science Camp and the Science Olympiad, both sponsored by Northern States Power, Cray Research and the Department of Education. Likewise, there are two main recognition programs for students in mathematics. One is the Young Math Program, which allows students to enroll in advanced mathematics courses at the University of Minnesota. Another is the

Minnesota Math League, sponsored by Macalester College, which is similar to an athletic league with competing teams and tournaments.

Summer Institutes, Magnet and Residential Schools

There is a special school for students studying mathematics located in the Minneapolis/St. Paul area. Approximately 150 students per year in grades 5-6 are selected, by examination, to participate in the program. Financial support to operate the school comes from the University of Minnesota and parents. There is also a six-week summer program for students in mathematics. Students must apply to the program; approximately 200 are selected to participate annually.

Special Populations

The state does not support programs to increase the participation of special populations, such as women and minorities, in science or mathematics.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

Higher order thinking skill items are incorporated in the state assessment and the item bank program. The High Technology Council is supporting a long-term project that would include assessment of higher order thinking skills.

Assessment Content

The state of Minnesota measures learner outcomes that were developed by the Curriculum Services Section of the State Department of Education in 1987.

Assessment Reporting

Assessment results are reported for the state, districts and schools. Results for the state are made public.

Schools, districts and state education policy makers use state assessment results for curriculum and instructional improvement.

Subject Areas Assessed

During the 1987 school year, a sample of students from grades 4,8 and 11 will be tested in mathematics, science and literature. During the 1988 school year, a sample of students from grades 6, 9 and 11 will be tested in writing, a sample from grades 3-8 will be tested in basic mathematics and a sample from grades 8-11 will be tested in computer literacy. In 1989, a sample of students from grades 7-12 will be tested in secondary reading and music. In 1990, a sample of students from grades 4, 8 and 11 will be tested in reading, social studies and visual arts. (This is a very tentative schedule.)

TEACHERS

Teacher Recruitment and Retention

A summer program in mathematics that gives teachers in other curricular areas an opportunity to earn a degree or licensure in physical science or mathematics is held annually at Bemidji State College. There have been no recent initiatives implemented by the state to attract or retain science teachers.

Teacher Shortages

Very small, rural schools generally have difficulty attracting qualified teachers, but there is no statewide teacher shortages in science or mathematics.

Certification Requirements

There are no specific requirements regarding the amount of training in science or mathematics individuals must have to receive elementary certification. However, teachers must be able to provide for the development of basic arithmetic operations, problem-solving skills, measurement techniques including the metric system, geometric concepts and computing devices.

The Middle School Science Certificate (grades 5-9) requires 40% of an individual's bachelor's degree to be divided among life, earth and physical sciences and chemistry. Middle school certification in mathematics is not available.

Secondary certification in mathematics requires at least 26 semester hours or 39 quarter hours of course work in specific mathematics courses.

Alternative Certification

Provisional licenses, valid for two years, may be issued to qualified persons if a demonstrated teacher shortage exists. Currently, there are no persons teaching science and only two persons teaching mathematics with this type of certification.

Teacher Training

To upgrade the skills of science teachers, the state education agency encourages colleges to offer National Science Foundation sponsored institutes, works with schools and colleges to provide inservices through Title II monies and organizes regional workshops with State Department of Education money. Two other institutes are held at the University of Minnesota, Minneapolis, and Mankato State University that focus on physics and life science.

To upgrade the skills of mathematics teachers, a physical science and mathematics summer institute that focuses on higher order thinking skills is held at Bemidji State College. Expenses are paid and teachers receive a stipend. Also, renewal units are required for licensure renewal; these units may include additional professional preparation.

Staff Development Needs

Science teachers need to be updated in general. Mathematics teachers at all grade levels need help with curriculum development, including instructional effectiveness. Elementary teachers should have more training in mathematics and teachers at the middle school level should have more advanced training in mathematics content.

FUNDING

Districts use Title II funds in various ways. Large local education agencies work individually while small local education agencies often combine forces in intermediate units.

No other state monies targeted to science or mathematics instruction have been made available to districts.

RECENT STATE REFORMS/NEW INITIATIVES

There have been no recent state reforms that have either promoted or hindered science or mathematics instruction.

TRENDS AND ISSUES

The three biggest problems that the state of Minnesota faces in improving science instruction are:

1. Definition and reform of the junior high science program;
2. Not enough "time on task" spent at the elementary and junior high levels;
3. Fear that elimination of rules and substitution of outcomes will result in testing for superficial outcomes rather than for higher order thinking skills; and
4. Reform from using a textbook-driven curriculum to a goal-based, hands-on course of study.

The three biggest problems that the state faces in improving mathematics instruction are:

1. Needed mathematics curriculum reform K-12 from textbook-driven instruction;
2. Lack of instructional effectiveness training; and
3. Incorporation of computers and other related technologies to aid the study of mathematics.

MISSISSIPPI

CURRICULUM

Curriculum Guides

The Mississippi Curriculum structure mandates course titles, course descriptions and minimum learning objectives, mandated for use in local Instructional Management Programs since July 1986. The curriculum structures for science and mathematics were developed under a contract between the state education agency, the University of Southern Mississippi, the Mississippi Science Teachers Association and the Mississippi Council of Teachers of Mathematics.

Higher Order Thinking Skills

There has not been a recent effort to emphasize the teaching of higher order thinking skills.

Time Requirements

In grades K-6, 250 minutes each of science and mathematics instruction are now recommended in Mississippi. In grades 7 and 8, 250 minutes per week are required for science and mathematics instruction.

Graduation Requirements

From 1984 to 1985, each school district in Mississippi established its own standards for graduation. In 1986, the Mississippi Commission on School Accreditation developed graduation requirements by subject area effective for the graduating class of 1988-89. Two units of science (including one laboratory based unit) and two units of mathematics will be required.

STUDENTS

Recognition and Awards

No statewide recognition or award programs were reported.

Summer Institutes, Magnet and Residential Schools

Summer institutes in Mississippi offer enrichment programs to high school students at Jackson State University and the University of Southern Mississippi.

Mississippi has a governor's school at the Mississippi University for Women in Columbus. Juniors in high school must be nominated by their schools to gain admission. The governor's school offers a balanced enrichment program in all curriculum areas.

Special Populations

The legislature recently approved the establishment of a special boarding school for gifted students in grades 11 and 12 focusing on science and mathematics. The school is scheduled to open for the 1988-89 school year.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

More difficult test items are provided instead of higher order thinking skills on the state's assessment instrument.

Assessment Content

A deliberate effort has been made through appointed committees to coordinate assessment content with curriculum objectives.

Assessment Reporting

Assessment results are reported for the state, districts, schools and students. Results for the state and districts are made public.

Assessment results are intended to be used by schools and districts for instructional improvement, and by state education policy makers for accreditation purposes.

Subject Areas Assessed

In 1987, all students in grades K, 1, 3-6, 8 and 11 will be tested in mathematics and reading. In addition, students in grades 3, 5, 8 and 11 will be tested in written communication, and students in grades 4 and 6 in writing, spelling, social science and science. The testing schedule will remain the same in 1988. In 1989, 1st graders will be dropped from the testing program.

TEACHERS

Teacher Recruitment and Retention

Loans of up to $3,000 for two years are available to undergraduates majoring in science and mathematics. Two years of the loan is forgiven for four semesters of teaching.

Loans of up to $1,000 per summer for three summers are also available to teachers who become recertified in science or mathematics. One thousand dollars is forgiven for every semester taught in high school in either science or mathematics.

Teacher Shortages

Teacher shortages are reported in both science and mathematics. The State Mathematics Improvement Task Force is preparing recommendations concerning teacher shortages for the State Board. A pilot plan to use satellite instruction in science is being conducted.

Certification Requirements

Elementary school certification (K-3 and K-8) general education requirements include 15 semester hours in science and mathematics, including three each in biological science, physical science, general mathematics, geometry and measurement, and electives.

Secondary school certification (7-12) general education requirements include 12 semester hours in science and mathematics, including three each in biological science, physical science, mathematics and electives.

Alternative Certification

As of 1986, persons may become certified through an alternate route. Requirements are a bachelor's degree including 12 hours of education courses, at least a 51st percentile score on the National Teachers Examination and passing scores on a first-year on-the-job evaluation. To date, approximately 50 people, in all fields, have taken advantage of this certification route.

Teacher Training

The state education agency is collaborating with teacher training colleges and universities on special programs to upgrade the skills of mathematics teachers in the state. The state is also participating in programs developed by the Southeast Educational Improvement Lab to improve skills using a "trainer of trainers" model. Similar training projects in the science field are being considered.

Staff Development Needs

The greatest staff development need among science teachers is content knowledge. The greatest staff development need among mathematics teachers is mathematics knowledge, among teachers not certified in but assigned to teach mathematics.

FUNDING

Mississippi is using Title II funds for tuition reimbursement for teachers to attend college classes, for teacher inservice programs on subject-matter-specific topics, to send teachers to state and national professional conferences and to purchase laboratory equipment and materials. Exemplary projects include: model laboratories for mathematics remediation, interactive television for teaching advanced classes, advanced placement mathematics training and course offerings for teachers, and incentive programs for teachers of gifted and talented students.

RECENT STATE REFORMS/NEW INITIATIVES

No recent reforms or new initiatives that affect science or mathematics instruction were reported.

TRENDS AND ISSUES

The three biggest problems in improving science instruction in Mississippi are:

1. Recruiting teachers;
2. Updating facilities and textbooks; and
3. Increasing student enrollment in science.

The State Mathematics Task Force in 1986 identified the following as the three biggest problems in improving mathematics instruction:

1. The curriculum needs more emphasis on problem-solving and higher-cognitive skills;
2. Teacher certification requirements for mathematics at the elementary level need to be more rigorous; and
3. There is a shortage of qualified teachers.

MISSOURI

CURRICULUM

Curriculum Guides

In 1986-87, Core Competencies and Key Skills for Missouri students were developed by committees of educators and administrators under the guidance of the Department of Education. The Core Competencies and Key Skills list recommends learner outcomes in science and mathematics for grades 2-10. A criterion-referenced test over the key skills is required by law.

Higher Order Thinking Skills

The learner outcomes listed in the Core Competencies and Key Skills stress higher order thinking skills in all areas of science, mathematics, language arts and social studies. The accompanying criterion-referenced test is designed to measure attainment of these skills.

Time Requirements

The Department of Education strongly recommends that students in grades 1-8 spend at least 150 minutes per week in each of the basic subject areas, including science and mathematics. Students in grades 9-12 are required to receive 6,900 minutes annually of science and mathematics instruction for two years. (This corresponds with the two Carnegie units in both science and mathematics required for graduation.)

Graduation Requirements

Since 1983, the State Board in Missouri requires two units in science and two units in mathematics to graduate. The College Preparatory Studies Certificate Program requires three units of science and three units of mathematics. Certificate candidates must earn a minimum G.P.A. in the combined areas of English/language arts, science, mathematics and social studies as calculated at the end of either the seventh or eighth semester of high school and must score above the national averages on the ACT and SAT.

STUDENTS

Recognition and Awards

There are no strictly state-supported recognition programs for students in science or mathematics. There are, however, local and regional science fairs sponsored by local school districts, colleges and universities. Students may also participate in the Missouri Junior Academy of Science, affiliated with and sponsored by the Missouri Academy of Science, and the Science Olympiad, sponsored by the Penn Valley Community College and the Missouri Department of Elementary and Secondary Education. The Missouri Council of Teachers of Mathematics sponsors contests for elementary and secondary students. The Council and professional engineers jointly sponsor and encourage Math Counts for junior high students.

Summer Institutes, Magnet and Residential Schools

Local monies and state desegregation funds financially support several special schools, which are located in Kansas City and St. Louis, for students in grades 7-12 studying science and mathematics. Students are selected through an application process. Approximately 1,100 students are enrolled in these schools annually.

The state also supports the Missouri Scholars Academy held at the University of Missouri-Columbia. Approximately 300 high school students are selected through a competitive application process to participate in the six-week summer program. A full spectrum of courses are offered, including several in the sciences and mathematics. Specific course offerings vary from year to year.

Special Populations

The Scholars Academy and the Science Olympiad actively seek participation from women, minorities and gifted students and all historically underserved groups.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

When the Missouri Mastery and Achievement Tests (MMATs) items were developed, the writers were instructed to design items that would assess higher order thinking skills. There has been a review by cognitive psychologists indicating that a good portion of the MMAT assesses higher level thinking.

Assessment Content

The Core Competencies and Key Skills served in the creation of MMAT. Items were written specifically to assess the particular Key Skills.

Assessment Reporting

Assessment results are reported for the state, districts, schools and students. Only state results are made public.

State assessment results are intended to disclose trend data; however, schools are more interested in objective mastery. State assessment results allow districts to determine to what degrees their performance levels are similar to the state performance level. Trend data has been developed for districts; however, using objective mastery information will again prove more useful.

State assessment results are the most useful to state education policy makers. Strengths and weaknesses, as they relate to the Key Skills, will provide policy makers with information regarding the comparative status of Missouri students with a national sample.

Subject Areas Assessed

During the four-year period from 1987 to 1990, a sampling of students in grades 3, 6, 8 and 10 will be tested in reading/language arts/English, mathematics, science and social studies/civics.

TEACHERS

Teacher Recruitment and Retention

The Missouri Prospective Teacher Loan Program provides up to $1,000 per year for three years to undergraduates who receive teacher training in a critical shortage area. Loans are forgiven or deferred for those who teach in one of these areas following graduation. The state supports a summer institute to retrain elementary teachers to teach mathematics in grades 7-9.

Teacher Shortages

There is presently no major shortage of science teachers. There is a shortage of mathematics teachers on paper but not in the classroom. Even though teacher shortages don't appear to be a major problem in Missouri, the state has taken steps to prevent such shortages. For example, teacher salaries were improved dramatically with the enactment of minimum salary legislation. Additionally, some colleges and universities are upgrading teacher preparation programs. Both initiatives will make the teaching profession more attractive and help to retain current teachers.

Certification Requirements

General requirements for elementary (grades 1-8) and middle school/junior high (grades 4-9) certification include one course in a physical or earth science and one course in a biological science, with at least one of these courses having a laboratory component, and a college-level mathematics course. Special elementary course requirements include five semester hours of mathematics appropriate for the elementary level. Secondary certification requirements for science include two semester hours in a physical or earth science and two semester hours in a biological science, with at least one of these courses having a laboratory component, and two semester hours of college-level mathematics. Specific subject area requirements for secondary certification include 30 semester hours of course work for mathematics, biology, chemistry, physics and earth science teachers.

Effective with the 1986-87 school year, new certificates must be renewed by completion of a professional growth plan. Life certificates are no longer issued. Some universities are moving to a fifth-year plan, but there is no state requirement for a fifth year at this time.

Alternative Certification

Individuals with a bachelor's degree may obtain a teaching credential following a transcript analysis providing they complete 24 semester hours of teacher education which includes student teaching. Very few people have taken advantage of this certification route since it was implemented.

Teacher Training

The state supports several activities to upgrade the skills of science and mathematics teachers. First, the state provides continuing inservice opportunities at the district and building level through Title II funds. Second, the state sponsors and holds several state-level mathematics-science-technology conferences throughout each year. Third, the

state assists districts in locating inservice providers in science and mathematics. In addition, the state was scheduled to release an inservice package for elementary mathematics by April 1, 1987.

Staff Development Needs

One of the greatest staff development needs among science teachers, especially at the elementary level, is to upgrade content background and teacher skills, including more emphasis on inquiry and process. Similarly, elementary teachers need stronger content knowledge and a broader range of methodologies in mathematics.

FUNDING

Districts are using Title II entitlements for science and mathematics inservice training in approximately equal proportions. Much of the activity is at the elementary level. Additionally, through the Incentives for School Excellence, a competitive grant program, districts may receive funding for science programs.

RECENT STATE REFORMS/NEW INITIATIVES

The Excellence in Education Act of 1985 stresses science instruction. It is too early to tell what the impact of the law will be, but preliminary findings indicate that elementary science is beginning to receive the attention it so badly needs. The Core Competencies and Key Skills Program has given direction to needed mathematics curriculum adjustment, especially in grades 7-9. The use of calculators on the state tests beginning at grade 7 is a great impetus to forward-looking change.

TRENDS AND ISSUES

The three biggest problems the state faces in improving science instruction are:
1. Upgrading teacher knowledge and teaching skills at the elementary level;
2. Infusing process and inquiry into the science curriculum at all levels; and
3. Acquiring additional funds targeted for science instruction.

The state is working in all of these problem areas. Progress is being made most significantly in improving elementary science and emphasizing process and inquiry.

Problems in improving mathematics instruction include:

1. An arithmetic-driven curriculum;
2. Low expectations for student achievement; and
3. Poor mathematics preparation in elementary teacher training programs.

All of these issues are receiving attention at the state level.

MONTANA

CURRICULUM

Curriculum Guides

Montana does not have state guidelines or requirements regarding curriculum for science or mathematics.

Higher Order Thinking Skills

Montana is promoting the teaching of higher order thinking skills through state conferences, regional workshops and district inservice programs.

Time Requirements

Grades 7, 8 and 9 are required to have 225 minutes per week of science instruction. It is estimated that 30% of all 7th and 8th grade classes and 7% of all 9th grade classes exceed these guidelines.

Graduation Requirements

The Montana Board of Education encourages schools to expand course offerings to meet the increasingly specialized needs of students. The graduating class of 1988 must complete a total of 18 units. The class of 1989 is required to complete one unit of a laboratory science and two units of mathematics. Work study, cooperative work experience and college-level courses taken during high school may be credited toward meeting the statewide minimums. Local districts are required to adopt policies addressing the needs of each student. These graduation requirements have not changed since they were adopted in 1970.

STUDENTS

Recognition and Awards

Several programs exist that recognize outstanding student performance in science and mathematics. These programs include the Junior Science Academy (grades 10-12), the U.S. Army Science Olympiad (grades 7-12), the Montana State University State Science Fair (grades 7-12) and the University of Montana Science Scholar Program (grade 12). In addition, the State Math Contest is held annually in which approximately 5,000 students in grades 7-12 participate. Local and regional awards are presented, and the highest achieving girl and boy each receive college scholarships.

Summer Institutes, Magnet and Residential Schools

Currently, the state does not sponsor any special schools for students studying science or mathematics. However, a magnet school for science students is under consideration.

Approximately 60 high school students are chosen to participate in summer institutes in which a variety of science courses are offered. Selection is based on academic and leadership skills. There are no similar programs available to mathematics students.

Special Populations

Expanding Your Horizons conferences, designed to make young women aware of the career possibilities in technical areas, are held in 11 sites around the state each year. The Native American Olympiad is held annually as well. Students of native American descent are encouraged to participate in this science- and computer-focused program.

STUDENT ASSESSMENT

Montana discontinued its voluntary student assessment program in 1984. Since that time, student testing decisions have been made at the local level.

TEACHERS

Teacher Recruitment and Retainment

There have been no recent initiatives implemented in Montana to attract or retain science or mathematics teachers.

Teacher Shortages

Montana is not experiencing teacher shortages in science or mathematics.

Certification Requirements

Seven to 10 credits of science are required by teachers seeking elementary certification, depending on the institution of higher education attended. One full year of mathematics content (not lower than college entry level) plus one quarter of mathematics methods is also required for elementary certification. Secondary certification requirements for science, like elementary certification, vary by institution, but 60 credits is the most common requirement. Secondary certification in mathematics typically requires the equivalent of a mathematics major plus a mathematics methods course. No middle/junior high school certification is available in Montana, nor does the state require professional study beyond the initial four years for certification.

Alternative Certification

A provisional certificate, valid for three years, is available to people who have completed at least 45 credits in an appropriate major and eight hours in professional education and who agree to complete a teacher preparation program within three years. Approximately 300 to 400 people have taken advantage of this certification route since it was implemented; 15 to 20 of those people became certified in mathematics.

Teacher Training

To upgrade the skills of science and mathematics teachers, the state education agency provides extensive inservice programs on state, regional and local levels. The agency also assists in sponsoring the Excellence for Montana Mathematics Education (EMME) project for K-8 teachers and the Integrating Mathematics Programs, Computer Technology (IMPACT) project for 7-12 teachers and Better Elementary Science Teaching (BEST) project for K-8 teachers. All are National Science Foundation funded cooperative

teacher enhancement programs involving MSTA, the Montana Council of Teachers of Mathematics (MCTM), the university system and public and private schools.

Staff Development Needs

Critical staff development needs, as identified by the statewide needs assessment in computer education, science and mathematics, include the following. At the elementary level, there needs to be more specific science content workshops in earth science, physical science and life science. In addition, elementary teachers need to understand more fully the use of hands-on, inquiry and activity approaches to teaching science. They also need to know how to use the computers and calculators as teaching tools in science.

Needs among elementary teachers in terms of mathematics are similar. Elementary teachers need more experience teaching problem-solving strategies and higher order thinking skills in mathematics. They also need to learn an activity approach and the use of manipulatives for mathematics instruction. Furthermore, elementary teachers need more information on the use of calculators and computers, estimation skills, and current trends in the mathematics curriculum.

Secondary science teachers need to learn how to use the computer as a science measurement, recording and analysis tool. There also needs to be workshops concerning science safety and specific science content.

Secondary mathematics teachers generally have the same needs as elementary mathematics teachers. They need to know how to use computers and calculators in teaching mathematics, how to teach problem-solving and higher order thinking skills in mathematics and how to take an activity approach to teaching mathematics.

FUNDING

Districts are using Title II funds for various inservice programs for science and mathematics teachers. In science, the most common inservice subjects are science safety, problem solving, science content and computer interfacing.

No additional state monies targeted to science and mathematics instruction have been made available to districts.

RECENT STATE REFORMS/NEW INITIATIVES

There have been no recent state reforms that have either promoted or hindered science or mathematics instruction.

TRENDS AND ISSUES

The biggest problems Montana faces in improving science instruction include providing teacher inservice to update content knowledge and teaching skills, increasing communication between teachers, and increasing available funds. Problems faced in improving mathematics instruction include upgrading teachers' skills, increasing teacher awareness of new teaching methods, and integrating computers into the mathematics curriculum.

NEBRASKA

CURRICULUM

Curriculum Guides

Nebraska is a local control state; therefore, there are no state curriculum guides or course frameworks for science or mathematics. However, Nebraska schools are required to have curriculum guides for each subject area that outlines the basic content to be presented to students.

Higher Order Thinking Skills

There has been a good deal of interest in higher order thinking skills in Nebraska's schools this year. Several state-level workshops were made available to interested people, and a number of districts are embarking upon some projects of their own.

Time Requirements

The state requires that schools offer the equivalent of four full-year courses in science and four full-year courses in mathematics each year in grades 9-12. A typical class would meet for 250 minutes per week.

Graduation Requirements

Effective in 1988, Nebraska law requires 200 credit hours for graduation with 80% of those credit hours in the core curriculum as defined by the State Board of Education. The core curriculum includes language arts, social studies, science, mathematics, vocational education, fine arts, and physical fitness and health education.

STUDENTS

Recognition and Awards

The Nebraska Academy of Sciences sponsors two recognition programs for secondary level students studying science. The Westinghouse Talent Search is for students in grades 9-12, and the Junior Academy of Science is for students in grades 7-12.

There are no recognition programs specifically for students studying mathematics.

Summer Institutes, Magnet and Residential Schools

The state does not support special schools (such as magnet or residential schools) or summer institutes for students studying science or mathematics.

Special Populations

The state does not support special programs designed to increase the participation of underserved populations.

STUDENT ASSESSMENT

Student assessment activities are determined at the local level and, at this time, no assessment data is collected at the state level. Although the state does not have a state assessment process as such, the state does provide incentives and initiatives through shared and cooperative activities that encourage schools to update and improve their educational programs.

Additionally, all Nebraska schools are required to set a minimum acceptable performance in reading, writing and computation and to continue working with all students until mastery of these skills has been attained. The state provides an assessment battery that schools may voluntarily use. This battery defines an acceptable performance level and has assessment activities to determine mastery of the identified skills. Schools using this battery are not required to report any scores to the state but rather are directed to use this information to assure their constituents that every effort is being made to equip their students with the essential learning skills.

TEACHERS

Teacher Recruitment and Retainment

Institutions of higher education may apply for student loans on the behalf of students enrolled in science or mathematics education. Recipients must agree to teach in Nebraska following graduation. The amount of the loan is $500/semester; for every semester taught, $500 of the loan is forgiven.

Teacher Shortages

The state does not have a shortage of science teachers; however, there is a shortage of mathematics teachers in some rural districts. Some small schools experience difficulty finding perspective teachers who are willing to teach five preparations and assume extracurricular responsibilities such as coaching.

Certification Requirements

To receive elementary certification (K-6), teachers must complete course work in all of the subject areas normally found in elementary school curriculum, including natural sciences and mathematics. Course work in science methodology and mathematics methodology must also be completed.

Middle grade certification (4-9) requires 30 semester hours of course work plus the minimum hours required in an area of specialization.

A Natural Science Endorsement at the secondary level (7-12) requires a minimum of 56 semester hours of course work, including 15 semester hours in biology, 15 semester hours in chemistry, 15 semester hours in physics and 6 semester hours in earth science. A Biology Endorsement requires 24 semester hours of course work. A Chemistry Endorsement requires 24 semester hours of course work, including inorganic chemistry, organic chemistry and analytical chemistry. An Earth Science Endorsement requires 24 semester hours of course work, including meteorology, astronomy, oceanography, paleontology, mineralogy, structural geology, economic geology, petrology and geomorphology. A Physical Science Endorsement requires 45 semester hours of course

work, including 18 semester hours in chemistry, 18 semester hours in physics and 9 semester hours in earth science. A Physics Endorsement requires 24 semester hours in physics.

A Mathematics Endorsement at the secondary level requires 30 semester hours of course work with demonstrated knowledge in college algebra, trigonometry, analytic geometry, calculus, abstract algebra, college geometry, computer concepts and applications, statistics and probabilities.

Nebraska does not require an additional year or a fifth year of professional education beyond the initial four years to become certified.

Alternative Certification

Students holding at least a bachelor's degree and who have passed the required tests may receive an emergency certificate upon the request of a local district with a teacher shortage. Lateral entry has been proposed but is not yet available.

Teacher Training

The state is encouraging teachers at all levels to upgrade their mathematics content skills.

Staff Development Needs

Science teachers in the state with Natural Science Endorsements need more course work in the physical science content area to make them feel more comfortable in subject area knowledge and methods. Likewise, mathematics teachers need to increase their mathematics content background. They also need more training in incorporating the use of calculators and computers in mathematics curricula.

FUNDING

Districts are using Title II funds for teacher inservice programs in subject area content, teacher retraining and teachers' travel expenses to professional meetings. No additional state monies have been allocated to districts for the improvement of science or mathematics instruction.

RECENT STATE REFORMS/NEW INITIATIVES

There are no recent state reforms that have promoted or hindered science or mathematics instruction.

TRENDS AND ISSUES

The three biggest problems Nebraska faces in improving science instruction are:

1. Increasing elementary school teachers' science competency;
2. Upgrading instructional technology available to teachers and students; and
3. Developing courses for nonacademic oriented science students.

The biggest problem the state faces in improving mathematics instruction is to integrate effectively new instructional technology into the mathematics curriculum.

NEVADA

CURRICULUM

Curriculum Guides

Nevada educators, under the direction of the state education agency, developed a required course of study for science and mathematics. The courses of study corresponding to grades K-6 were last revised in 1984. Revisions were recently completed for grades 7-12.

Higher Order Thinking Skills

There has been no recent effort by the state to emphasize the teaching of higher order thinking skills in science. However, the Department of Education is offering problem-solving workshops for K-6 mathematics teachers.

Time Requirements

The state recommends that students in grades 1-3 receive 90 minutes of special instruction per week. Two hundred minutes per week are recommended for grades 4-6, and 250-300 minutes are recommended for grades 7-12.

There are no time recommendations for mathematics instruction.

Graduation Requirements

In November 1986, the Nevada State Board of Education increased high school graduation requirements (beginning with the freshman class of 1988) to two years of science and two years of mathematics. Demonstrated computer competency or one-half year of computer science is required. A competency examination is required in mathematics prior to graduation; no diploma will be awarded until passage. No changes to these requirements are being proposed.

STUDENTS

Recognition and Awards

There are no recognition programs for students in science or mathematics at the state level. However, Nevada does participate in various scholarship programs and the West Virginia National Youth Science Camp.

Summer Institutes, Magnet and Residential Schools

Nevada does not support magnet or residential schools for students studying science or mathematics. Nor does the state support summer institutes for students especially interested in these subjects.

Special Populations

Currently, there are no programs that serve underrepresented students in science at the state level, but the state education agency does encourage local districts to sponsor such programs.

Sections of computer workshops for teachers include discussions of equity in computer use and awareness of special problems of women and minorities. The state has also conducted "Odds on You," mathematics workshops for young women to encourage consideration of taking advanced mathematics classes and entering mathematics careers.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

The most recent revision of the state's test objectives incorporated more higher order thinking skills. For example, more multistep mathematics problems have been added to the test as well as inferential and critical-level reading problems.

Assessment Content

The existing state-level tests do not have well-established links with the required courses of study. However, a complete revision of the testing program, with this link as one of its major goals, is being planned.

Assessment Reporting

The state reports assessment results for students, schools and districts. Results for districts and schools are made public.

In the past, assessment results have been used at the school and district levels primarily for individual student remediation and as a graduation requirement. In the future, they will be used to guide instruction on a broader basis and to direct curriculum development. State education policy makers use assessment results to evaluate the state's education status.

Subject Areas Assessed

During the 1987 school year, every student in grades 3, 6, 9 and 11 will be tested in mathematics, writing and reading skills. This testing schedule will remain the same through 1990.

TEACHERS

Teacher Recruitment and Retention

Nevada has not implemented any recent initiatives designed to attract or retain science or mathematics teachers.

Teacher Shortages

The state is experiencing teacher shortages in science and mathematics. Many science classes are taught by teachers with only minor qualifications. Likewise, many school districts are staffing mathematics programs with teachers who are minimally qualified (mathematics minors).

Certification Requirements

There are no requirements in terms of the amount of training people must have in science or mathematics to become certified in elementary education. Secondary certification in science requires either a major (36 semester hours) or a minor in science. Secondary certification in mathematics also requires either a major (30 semester hours) or a minor (16 semester hours) in mathematics. No certification is available specifically for the middle/junior high school levels.

Alternative Certification

Emergency certificates may be issued to underqualified persons by the State Superintendent if a school district cannot find a qualified teacher to fill the vacant position. Approximately 20 persons per year are on an exceptions list to teach science with an emergency certificate.

Teacher Training

The state education agency offers workshops to elementary teachers to upgrade their science and mathematics skills. No workshops are provided to secondary-level teachers.

Staff Development Needs

Teachers of grades K-12 need to update their science and mathematics content and problem-solving skills.

FUNDING

Districts are using Title II funds for elementary science and mathematics workshops.

No additional state monies targeted to science or mathematics instruction have been made available to districts.

RECENT STATE REFORMS/NEW INITIATIVES

There has been no recent legislation that has affected science or mathematics instruction.

TRENDS AND ISSUES

Before science instruction can be improved in Nevada, science education needs to become a high priority. The state also needs to recruit more qualified teachers. Furthermore, the rule that allows the one science credit required for graduation to be filled by taking vocational courses must be repealed.

NEW HAMPSHIRE

CURRICULUM

Curriculum Guides

New Hampshire Standards for Approval, developed by the state education agency and a committee of educators, cover all curricular areas and include required objectives for science and mathematics programs. Secondary course outlines are available and are recommended for use by districts (a new course outline for computer education is now available). The standards for grades 1-8 were last revised in 1987; the standards for grades 9-12 were revised in 1984.

Higher Order Thinking Skills

No particular effort to emphasize higher order thinking skills was reported.

Time Requirements

The state recommends 150 minutes per week of science instruction for grades 1-3, 158 minutes per week of science instruction for grades 4-6, 200-250 minutes per week for grades 7 and 8 and 250 minutes per week for grades 9-12. Thirty percent of 5th and 6th grade classes, 40% of 7th and 8th grade classes and 100% of secondary science classes meet or exceed these guidelines. State time recommendations for mathematics instruction are 200 minutes per week in grades 1-3, 250 minutes per week in grades 4-6, 250-300 minutes per week in grades 7-8 and 250 minutes per week in grades 9-12.

Graduation Requirements

Beginning with the class of 1989, one-half unit of computer education, two units of mathematics and 2 units of science will be required to graduate from New Hampshire high schools. New Hampshire does not require a competency examination prior to high school graduation. The State Board provides guidance on the content of the program of studies and requires all students to complete successfully all units of credit to graduate.

STUDENTS

Recognition and Awards

Students in New Hampshire participate in various national programs such as the West Virginia National Youth Science Camp and the U.S. Department of Energy Summer Honors Programs.

No mathematics recognition programs are reported.

Summer Institutes, Magnet and Residential Schools

State support for special schools is under consideration in New Hampshire.

Special Populations

A number of workshops for teachers have been funded in this area using funds provided by Title II and the Governor's Initiatives for Excellence in Education. In addition, EQUALS workshops, which address the issue of women in mathematics, are sponsored on a regular basis.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

There is no formal approach to higher order thinking skills on the state level; however, some local school districts are experimenting with the idea.

Assessment Content

Curriculum guides are developed locally in New Hampshire. State curriculum consultants review test results with local staff to help coordinate local curriculum guides with assessment content.

Assessment Reporting

Assessment results are reported for the state, districts, schools and students. Results are also made public.

Assessment results are intended to be used by schools for local program evaluation and for curriculum review and improvement. Districts are expected to use results for local curriculum review and development and for sharing information among schools. State education policy makers are intended to use results for curriculum development and improvement of instruction as well as some limited comparisons among districts.

Subjects Assessed

Students in grades 4, 8 and 10 are assessed annually in mathematics, reading, writing, social studies, language arts and science.

TEACHERS

Teacher Recruitment and Retention

No recent recruitment efforts were reported.

Teacher Shortages

There is a shortage of physical science and earth science teachers in New Hampshire. These disciplines have been identified as teacher shortage areas under the critical shortage staffing clause of the New Hampshire Certification regulations. As a result, individuals who are not fully certified may be hired and placed on individualized teacher certification plans. Title II monies support training in these areas.

Shortages of mathematics teachers are reported and are being addressed through emergency provisions that allow teachers out-of-field to teach mathematics while

completing certification requirements. Title II monies are used to fund summer institutes, courses and workshops for noncertified staff.

Certification Requirements

New Hampshire uses an approved program format for teacher certification. Generally a minimum of one content course in science is required and the state recommends two content courses.

Middle school certification in science is available; it is competency based. Generally, 12 science courses would be necessary to cover the survey requirements in the earth, biological and physical sciences with indepth preparation in one of these. The approved program system for middle school certification in mathematics requires competencies in foundations, algebra, geometry, analysis, probability and statistics, computer programming and applications. Six to seven courses are usually sufficient to cover these topics.

Secondary certification in science is competency based with specific certification in biology, earth science, physical science, chemistry and physics. Usually 10 to 12 content courses are necessary for certification in each of these areas. Secondary certification in mathematics under the approved program system essentially requires an undergraduate major in mathematics. Most of the colleges require 10 to 11 content courses.

Alternative Certification

People with a bachelor's degree and teaching experience who have not completed an approved teacher education program may become certified after passing a subject area written and oral examination.

Current teachers may also become recertified in an area of critical need through a similar internship program which includes support from a mentor teacher. In addition, qualified candidates may become certified to teach science or mathematics through an Individualized Professional Development Plan. In science, approximately 60 individuals are currently teaching under approved plans.

Teacher Training

The state education agency, in cooperation with the New Hampshire Science Teachers Association, provides summer institutes, workshops and courses in all science disciplines and at all grade levels. Workshops are also provided for mathematics teachers.

Staff Development Needs

There is a critical need for preparing elementary teachers in the area of science. At the junior high and high school levels, teachers need assistance in expanding science to include science, technology and society concerns and to provide alternative courses to meet the needs of all students.

The greatest staff development need among mathematics teachers is content courses, especially courses in geometry and algebra.

FUNDING

Title II funds are used to support courses, workshops, conference attendance, and underwriting summer and academic-year study by noncertified teachers and to update the skills of certified staff.

Monies available under the Governor's Initiatives for Excellence in Education have supported the incorporation of new teaching technologies in science instruction.

RECENT STATE REFORMS/NEW INITIATIVES

No recent initiatives were reported that have affected science or mathematics instruction.

TRENDS AND ISSUES

The three biggest problems New Hampshire faces in improving science instruction are:

1. Need for expansion of science instruction in grades K-6;
2. Need for expansion of science instruction in grades 7-12 to meet the needs of all students; and
3. Ensuring that all science teachers are qualified for their teaching assignments.

The three biggest problems the state faces in improving mathematics instruction are:

1. Assuring that all who teach mathematics are qualified;
2. Effecting better articulation between school and college programs; and
3. Determining how best to use the technology now available to improve teaching/learning (e.g., how to use graph packages; integrate the geometric supposer into instruction; other computer uses).

NEW JERSEY

CURRICULUM

Curriculum Guides

The New Jersey state education agency has developed recommended curriculum guidelines in science and mathematics for grades K-6 to be used as benchmarks for local program development. These guides were revised in 1986. In addition, a mathematics skills array, developed by a committee of educators, parents, industry and university representatives, is recommended for inclusion in grades 7-9. These skills are tested at grade 9 as part of the High School Proficiency Test (HSPT). Passing this test is one of the high school graduation requirements.

Higher Order Thinking Skills

Problem solving is one of the seven clusters of skills tested on the mathematics portion of the HSPT. Higher order thinking skills are also tested in reading and writing. In addition, the geometry cluster contains multistep, complex test items.

Time Requirements

There are no state regulations on the quantity of time spent on science instruction and mathematics instruction at the elementary grade levels. Generally, students are exposed to five periods of science and mathematics per week; however, the length of each period varies with each district. In the high school there must be a minimum of 40 minutes of instruction daily for each year of science and mathematics required.

Graduation Requirements

(Note: New Jersey does not use Carnegie units.) New Jersey high schools require two credit years of computation and one credit year of natural or physical science. Effective in 1989, two units of science are required for high school graduation. Additional changes include a third year of mathematics for the 1990 freshman class. All diplomas must be state endorsed and issued only if both the statewide HSPT and state and district minimum curriculum requirements are met. Those who do not pass the proficiency tests do not receive a diploma.

STUDENTS

Recognition and Awards

Recognition and award programs in New Jersey include a State Science Day, SEER Science Fairs, Governor's Science Camp, National Department of Energy Student Science Camps and the Governor's Science Academy (Advanced Summer Study). Professional organizations sponsor special programs in mathematics.

Summer Institutes, Magnet and Residential Schools

In 1984, a Governor's School of Science and Technology opened. These schools are attended by the pool of "best" academic students in a specific content area.

Special Populations

Special programs to increase the participation of women, minorities and gifted students are sponsored by New Jersey's urban school districts, through the Science Research Program and by the Office of Equal Educational Opportunity, usually in cooperation with state universities and post-high school education institutions.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

The new HSPT is a more rigorous assessment of basic skills than the former minimum competency test. For example, the reading test emphasizes inferential comprehension, mathematics emphasizes problem solving and writing includes an essay.

Assessment Content

There are no state-mandated curriculum guides in New Jersey. The skills array of the HSPT serves as a guideline to local curriculum development. For example, all tested skills should be included for mastery in a district K-9 curriculum.

Assessment Reporting

Assessment results are reported for the state, districts, schools and students. Results for the state, districts and schools are made public.

Assessment results are intended to be used by schools and districts to identify students lacking proficiency, to provide remediation and to provide information on program strengths and weaknesses. The HSPT is a graduation requirement. State education policy makers will use the passing rates to identify districts in greatest need of assistance and to generate $150 million in compensatory aid.

Subjects Assessed

Students in grade 9 are assessed in reading, mathematics and writing by the state's HSPT. All other grades are assessed annually in reading, mathematics and writing by locally selected state approved commercial standardized tests.

TEACHERS

Teacher Recruitment and Retention

In addition to a minimal new teacher salary, New Jersey is working to recruit and retain teachers through a Dissemination Site Program at Trenton State College with the support of the Department of Higher Education. Additionally, Rutgers University and the Department of Higher Education offer a first-year Teacher Support Program for all new science and mathematics teachers in the state.

Teacher Shortages

No teacher shortages are reported in science, but shortages are reported in mathematics, predominantly in the urban areas. These are being addressed through the teacher retraining program and the Commissioner's Alternate Routes Certification programs.

Certification Requirements

New Jersey is in the process of revising certification requirements, but as of this writing, science and mathematics credential requirements for elementary certification are determined by the college or university's program. No middle school/junior high school certification is available in the state. Training to teach secondary school science or mathematics is dependent upon the college or university program (typically, 24 credit hours are required for a specific content area in science, and 30 hours are needed for comprehensive science).

Alternative Certification

In September 1984, the State Board of Education adopted revised certification regulations that provide an alternate route to certification for applicants who have not completed education courses or student teaching. Applicants must have a bachelor's degree from an accredited institution, an academic major in the appropriate teaching field and must pass the National Teachers Examination. Upon successful completion of a one-year provisional teacher program, an applicant in the alternate route to certification program will be eligible for a regular certificate. The alternate route to certification allows districts to hire qualified applicants who are knowledgeable in the subject matter of the teaching field. Under current regulations, district training programs are offered for all instructional areas except special education, bilingual/ESL education and vocation education. Certificates are issued in subject fields (K-12), elementary education (K-8) and nursery education (N-K).

Teacher Training

The state education agency is working to upgrade the skills of science teachers through training, seminars and programs. For example, state-supported summer institutes for teachers of mathematics are being provided at three regional curriculum centers. The statewide New Jersey Algebra Project focuses on algebra instruction and teacher training. Each year the State Department of Education hosts a series of training workshops for elementary teachers of science.

Staff Development Needs

The greatest staff development need of science teachers is process skill training. In mathematics, methods and content deficiencies have been identified by administrators and supervisors. Skill in teaching problem solving, understanding number systems and use of manipulative materials is needed.

FUNDING

Districts are using Title II funds for teacher training, and some cooperatively pool their funds for workshops. About 20% of the districts were approved for waivers to address

"other than" science or mathematics instruction. Additional state monies have been made available for teacher training and remedial student assistance in science and mathematics.

RECENT STATE REFORMS/NEW INITIATIVES

Recent reforms and initiatives include: an Elementary Science Initiative, statewide science needs assessment, an increase in the mathematics requirements for graduation, the institution of HSPT graduation test, a state focus on curriculum and instructional guidelines, and development of teacher resources focused on the mathematics skills identified in the skills array.

TRENDS AND ISSUES

The three biggest problems New Jersey faces in improving science instruction are:

1. Training of elementary teachers;
2. Adopting an additional one-year service requirement; and
3. Training of science supervisors.

The biggest problems in improving mathematics instruction are:

1. Training and retraining mathematics teachers;
2. Classroom instruction to emphasize HSPT skills; and
3. Retraining potential drop-out students through alternate student programs.

NEW MEXICO

CURRICULUM

Curriculum Guides

New Mexico has a set of learner outcomes for all subjects including science and mathematics, that contain essential competencies for grades 1-8 and high school exit level competencies for grades 9-12. The outcomes were developed by an advisory committee, a State Department of Education in-house committee and teachers. High school students must pass a test on the exit level competencies to receive a diploma; the essential competencies (1-8) are not currently required to be tested. The exit level competencies were last revised in July, 1983. The essential competencies that are required for grades 3 ,5 and 8 were revised in March 1985 and were again revised in March 1987 for grades 1-8.

Higher Order Thinking Skills

The state emphasizes high order thinking skills in several ways. Problem-solving and process skills are integrated into the essential and exit level competencies. State Department of Education specialists are developing workshops on critical thinking skills. The state is also adopting mathematics textbooks that emphasize problem solving.

Time Requirements

Students in grades 4-6 must receive at least four hours of science instruction per week. When 6th grade is part of a middle school, one science class per day is required. Science is optional for 7th grade students, but 8th grade students must receive science instruction for one class period per day. Students in grades 9-12 are required for graduation to take two science courses, one of which must include laboratory experience.

Three hundred minutes per week of mathematics instruction is required in grades 1-6. Students in grades 7 and 8 must receive mathematics instruction for at least one hour per day. Students in grades 9-12 must take at least three years of mathematics to graduate.

Graduation Requirements

Schools in New Mexico are required to prepare an individual program of study for each student at the end of the 8th grade. Since September 1986, students have been required to take two units of science, one with a laboratory component, and three units of mathematics to graduate from high school. Only selected electives count toward graduation requirements. These include science, mathematics and computer science. Local districts may have alternative graduation requirements but they must address the competencies required by the state board. Beginning with the class of 1990, passage of a competency test is required prior to graduation. Exemption from the high school proficiency examination shall be determined by the Educational Appraisal and Review Committee. Those exempted from the proficiency examination who otherwise complete the course of study are entitled to a regular diploma or certificate of completion without mention of the proficiency endorsement. No changes in these requirements are being proposed.

STUDENTS

Recognition and Awards

There are no recognition programs for students in science or mathematics at the state level. However, there are local, regional and state science fairs that are voluntary, as are the Science Olympiad and Junior Academy of Science. Agencies outside New Mexico (e.g., West Virginia, the Department of Energy and the National Institute of Health) also support student recognition programs. In mathematics, there are local and state levels of competition for junior high and senior high school students. These are sponsored by private engineering firms, state universities and professional organizations.

Summer Institutes, Magnet and Residential Schools

New Mexico does not have special schools or summer institutes for students studying science or mathematics; the legislature cut these programs from the budget in 1986.

Special Populations

The state does not support special programs for underserved and underrepresented groups.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

The state does not specifically assess higher order thinking skills.

Assessment Content

In grades 3, 5 and 8, a state-developed supplement to the Comprehensive Test of Basic Skills is available to assess the essential competencies. Future plans call for a customized test in grades 3, 5 and 8 with embedded norm-referenced items.

Assessment Reporting

Assessment results are reported for the state, districts, schools and students. Results for the state and districts are made public.

Student achievement information gathered by CTBS/PACE for grades 3, 5 and 8 should be used by schools to monitor student progress and program strengths and weaknesses. For grades 1 and 2, reading assessment results should be used by schools to monitor achievement and to determine where remediation is necessary. For grades 4 and 6, writing assessment results should be used by schools to determine where diagnostic remediation is needed. Assessment results in grade 10 should be used as a basis for graduation. Districts should use student assessment results to evaluate curriculum and to monitor student and school progress. State education policy makers should use assessment results to monitor overall student progress, to inform the public of the status of student achievement and to add to the state's data base for accreditation decisions.

Subject Areas Assessed

In 1987, every student in grades 3, 5, 8 and 10 will be tested in reading, language arts, mathematics, science and social studies. The state's assessment program will be expanded in the years 1988 to 1990. During that time, students in grades 1, 2, 3, 5, 8 and 10 will be tested in reading; students in grades 3, 5, 8 and 10 will be tested in social studies, mathematics, language arts and science; and students in grades 4, 6 and 10 will be tested in writing.

TEACHERS

Teacher Recruitment and Retention

On June 27, 1986, the State Board of Education adopted an Alternative Licensure Program for distinguished scholars who have not completed teacher preparation programs. The State Superintendent of Public Instruction may grant a renewable, one-year license to such persons if it is requested by a local school board or the governing authority of a private school. People recommended for the distinguished scholar program must successfully complete the National Teachers Examination Core Battery and any required NTE Specialty Area Test. The superintendent of the employing school must outline the qualifications and related experience of the recommended person and how the instructional program will benefit from both, describe the support to be provided and describe the evaluation process that will be utilized.

Teacher Shortages

The state does not currently have a shortage of science teachers but does have a shortage of mathematics teachers. Since there tends to be vacancies for mathematics teachers and coaches each year, more and more districts give a priority to mathematics/coaching applicants over better qualified mathematics teachers who do not coach. Usually, mathematics teachers/coaches only teach lower level classes. Thus, state is experiencing a shortage of higher level mathematics teachers.

Certification Requirements

Three semester hours of mathematics are required for elementary certification; science is optional. Secondary certification in science and mathematics both require 24 semester hours of course work in the appropriate subject area.

The state does not have a certification requirement for professional teacher education experience beyond the initial four years.

Alternative Certification

The Alternative Licensure program described above is available for all subject areas. In 1986, approximately 10 people used this alternate route to become certified in mathematics.

In addition, an intern program in the Santa Fe School District in cooperation with St. John's College and the University of New Mexico trains people with degrees in education, assigns them to teach in pairs (at half pay) and after two years plus a one-year internship, grants them regular certification.

Teacher Training

To upgrade the skills of mathematics teachers, the state, in cooperation with state colleges and universities, sponsors workshops on mathematics curriculum topics and summer institutes on mathematics.

Staff Developement Needs

Science teachers need to learn about current scientific innovations and findings and the impact they have on society. Teachers also need to learn new classroom teaching strategies. Furthermore, there needs to be more interaction of science teachers with their peers and other members of the profession.

Elementary teachers especially need more mathematics training.

FUNDING

Districts are using Title II funds for training teachers in uses of science and mathematics computer software, hands-on (manipulatives) methods of teaching science and mathematics, instructional materials and curriculum development. No additional state monies targeted to science or mathematics instruction have been made available to districts.

RECENT STATE REFORMS/NEW INITIATIVES

There is a change from endorsements in specific science areas to only a broad science endorsement. Many science teachers are concerned about how little science one needs for the endorsement.

The new three-year graduation requirement in mathematics has promoted mathematics instruction.

TRENDS AND ISSUES

The barriers New Mexico faces in improving science instruction include lack of time for science at the elementary level, lack of safety in the laboratory including the storage and disposal of hazardous materials, and uncertainty about licensure programs for science teachers.

The state is holding annual safety seminars and conducting onsite visits as requested by schools to reduce the hazards of unwanted, unneeded and outdated chemicals and to provide information to teachers to help them establish safety programs in their schools.

The problems the state faces in improving mathematics instruction include lack of money for education, lack of training in mathematics curriculum and in current teaching methods and low priority given to mathematics instruction.

NEW YORK

CURRICULUM

Curriculum Guides

The New York science and mathematics syllabi and guides were developed by the state education agency with the assistance of an advisory committee and a team of writers. The syllabi and guides are recommended for use by local districts.

Higher Order Thinking Skills

Higher order thinking skills concepts are incorporated into the state science and mathematics syllabi at all grade levels. In addition, a publication entitled Creative Problem Solving is available and designed for use by mathematics teachers in grades K-9. A problem-solving publication in mathematics for high schools is currently being developed.

Time Requirements

The state recommends that 5th and 6th grade students spend 10% of the school day, or 165 minutes per week, on science. An estimated 40% of 5th grade classes and 60% of 6th grade classes exceed the guidelines. In grades 7-9, 180 minutes of science instruction are required. Because most classes are at least 40 minutes long, virtually all classes exceed the requirement.

The state recommends a minimum of 180 minutes per week of mathematics instruction in grades 7-12.

Graduation Requirements

Students entering 9th grade in 1985 or later in New York must earn two units each in both science and mathematics for either the local diploma or the Regents' Diploma. They must also take two sequences for the Regents' Diploma. Science and mathematics are two of the choices for sequences. Requirements for a local diploma differ in testing requirements. Competence in basic skills is required and is measured by passage of the Regents' Competency Tests or examinations in science and mathematics. Remediation is provided if needed. Regents' Diploma candidates must pass the Regents' Examinations in science and mathematics.

STUDENTS

Recognition and Awards

The Science Olympiad is a state-sponsored recognition program. State students also participate at the national level in the National Youth Science Camp, Department of Energy High School Student Programs and the NIH Centennial Scholars Program. The New York State Energy Research and Development Authority sponsors an Energy Research and Design Competition, and the Science Teachers Association of New York State sponsors a Science Congress.

There are no state-sponsored mathematics recognition programs. There are regional, state-wide and national mathematics contests and fairs sponsored by schools, commercial groups and the Atlantic Coast Math League. Most are at the junior and senior high school levels. The Mathematics Olympiads for elementary schools involves several written tests and is sponsored by a Long Island group.

Summer Institutes, Magnet and Residential Schools

Local districts may establish special programs for gifted middle school students in science using funds disbursed under the state aid formula. Special legislative grants for gifted programs are also offered each year. While the state does not offer magnet school funding for science, planning grants are available to districts wishing to apply for federal funding.

There are many special schools initiated locally, with students selected according to test scores and teacher recommendation. Some examples are the Stuyvesant High School and Bronx High School of Science in New York City, the Buffalo Honor School and a Buffalo mathematics-science school being developed based on the Stuyvesant High School model.

Special Populations

The New York State Department of Education has a suggested listing of sources of materials about women, Native Americans and other minorities. The state education agency also established a Commissioner's Advisory Council on Excellence and Equity in Math and Science, and conducts equity workshops around the state.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

Questions measuring higher order thinking skills are included in all tests.

Assessment Content

State curriculum guides for all subjects tested are available. Test blueprints link tests to curriculum.

Assessment Reporting

The state reports assessment results for schools and districts. Results for schools and districts are made public.

Assessment results are intended to be used to drive school improvement efforts, and for districts to provide a measure of school and district accountability. State education policy makers use the results for state accountability, planning, resource allocations, etc.

Subject Areas Assessed

New York students are assessed annually as follows:

Mathematics — grades 3, 6, 9-12
Reading — grades 3, 6, 8, 11
Writing — grades 5, 8, 11

Social Studies — currently 11th grade only; grades 6, 8 and 10 planned
Language Arts — grade 11
Science — currently grades 9-12 only; grade 6 is planned
Foreign Languages — grade 11
Occupational Subjects — grades 9-12

TEACHERS

Teacher Recruitment and Retention

In 1987, several million dollars were allocated for forgivable loans for graduate and undergraduate students training to become certified in areas of critical shortages.

Teacher Shortages

Shortages of science and mathematics teachers are reported primarily in large urban areas. Many of the Title II higher education programs are aimed at retraining teachers for science and mathematics, and state scholarships for teacher training may alleviate shortages.

Certification Requirements

Provisional Upper Elementary and Academic Subject in Early Secondary certificates require 36 semester hours in general science or 18 semester hours in mathematics. Provisional certificates for teaching academic subjects at the secondary level require 36 semester hours of science or 24 semester hours of mathematics (including college-level calculus). A master's degree is required for permanent certification. Provisional certificate requirements for mathematics may be increased from 24 semester hours to 36 semester hours and the Early Secondary Certification may be eliminated.

Alternative Certification

Individuals with a bachelor's degree who have passed the NTE and a transcript review (conducted by the State Board of Education) may receive certification. Additional course work may be recommended based on the transcript review. A one-year paid position in an approved school may substitute for student teaching. More than 20% of the state's certified teachers have taken advantage of this certification route.

Teacher Training

To upgrade the skills of science and mathematics teachers, the state education agency presents workshops and offers inservice programs. Federal funds for special programs through colleges and universities are available, and the state education agency developed extensive guides and booklets on various topics, such as probability, problem solving, computers, manipulations, etc. Also, the Teacher Summer Business Training and Employment Program provides a portion of salary reimbursement for teachers employed by business and industry during the summer. Four million dollars is allocated to the program. Teachers must be in science, mathematics, computers or occupational education fields.

Staff Development Needs

Elementary teachers need to know how to implement the state's elementary science syllabus. They specifically need training in science content hands-on activities and problem solving. Classroom management of materials and time and integration of science with other subjects need to be stressed.

The greatest staff development needs among mathematics teachers are making problem solving an integral part of all lessons and, for teachers beyond grade 3, using manipulatives and hands-on activities.

FUNDING

Title II funds primarily are used for inservice programs in science, mathematics and foreign languages.

Additional state monies are indirectly available for mathematics instruction — schools scoring below statewide reference points on 3rd grade, 6th grade and high school competency tests in reading, writing and mathematics are targeted for special work.

RECENT STATE REFORMS/NEW INITIATIVES

Recent state reforms that have promoted science and mathematics instruction include an increase in the science and mathematics high school graduation requirements to two years each, and college preparatory courses are required for the Regents' diploma. Revision of the high school curriculum has also resulted in increased retention of teachers of grades 3 and 4. Another requirement to provide accelerated high school subjects to 8th grade students who are ready has also promoted science and mathematics.

TRENDS AND ISSUES

The three biggest problems the state faces in improving science instruction are:

1. Sufficient resources must be provided to improve elementary science. The state needs to train enough mentors (turn-keys) to effectively reach 80,000 elementary classroom teachers. This would require indepth, long-term training for mentors and indepth, long-term technical assistance to teachers and administrators;
2. Science programs at the middle junior high school level must be strengthened. The state needs to ensure that science courses are developmentally appropriate for the students at this level. Courses must be concrete and contain hands-on activities that are related to the real world and able to prepare students to be effective problem solvers; and
3. Massive amounts of technical assistance in science is needed by those schools in New York state (approximately 500) identified as its lowest-performing schools. While across-the-board school improvement efforts are underway, specific assistance is needed in science. This is an equity issue also, since the students in these schools tend to be poor and/or minority.

The three biggest problems New York faces in improving mathematics instruction are:

1. Getting students interested in teaching careers;
2. Promoting the importance of teaching for more than a test and moving from management programs to address more difficult behavioral objectives; and
3. Soliciting wider teacher participation in professional conferences and inservice courses.

NORTH CAROLINA

CURRICULUM

Curriculum Guides

North Carolina's curriculum guides for all subjects outline a broad education plan and a standard course of study. The state education agency, with the assistance of classroom teachers, superintendents and university personnel, developed the Competency Based Curriculum Program in 1984-85. Included are goals, objectives and measures for each subject in grades K-12. State-supported schools are required to use the guides.

Higher Order Thinking Skills

Higher order thinking skills have always been emphasized in science in North Carolina while problem solving has been a major emphasis in mathematics in the past few years. A section of the Competency Based Curriculum focuses on thinking skills, and additional guides addressing higher order skills are being developed. A four-day institute was recently held in Raleigh on higher order thinking skills and was attended by educators from each of the state's educational regions, who then held workshops themselves.

Time Requirements

North Carolina students in grades K-5 are likely to spend approximately 20-30 minutes per day on science instruction; students in grades 6-8 spend approximately 45 minutes per day in science classes; 9th through 12th graders spend approximately 55 minutes per day on science instruction. Because class times are scheduled, few schools exceed the guidelines. There are, however, no specified state requirements regarding the amount of time to be spent on science or mathematics.

Students in grades K-8 receive approximately 45 minutes per day of mathematics instruction and students in grades 9-12 receive approximately 55 minutes per day of mathematics instruction.

Graduation Requirements

Starting with the graduating class of 1987, the State Board of Education in North Carolina requires two units in science (one life science and one physical science) and two units of mathematics. Passage of a competency test in mathematics, reading and writing is required by state law for graduation. The test is administered to 10th graders; remediation is provided and testing opportunities exist through the 12th grade. Beginning with the class of 1988, entrance into North Carolina's public university system will require three units of science and three units of mathematics, thereby providing a de facto requirement for college-bound students.

STUDENTS

Recognition and Awards

North Carolina offers state and regional science fairs and the North Carolina Junior Academy of Science (affiliated with the Academy of Science), and participates in programs sponsored by other agencies such as the West Virginia Youth Science Camp, junior science and humanities programs, and the Science Olympiad.

The state participates in the Math Counts program, and a state team participating in national competitions in Washington, D.C. In addition, students enrolled in Algebra I, Geometry, Algebra II and higher level mathematics courses are recognized through participation in local and regional mathematics contests. One hundred and ten students qualify to compete in a statewide contest by scoring in the top 10% in the comprehensive mathematics categories on exams given at various test sites across the state. The events are sponsored by the North Carolina Council of Teachers of Mathematics and the mathematics division of the state education agency. The top 15 students at the state contest compose a team that then competes in ARML (Atlantic Region Mathematics League). Many of the top students at the state contest receive scholarships to attend various North Carolina colleges and universities.

Summer Institutes, Magnet and Residential Schools

The North Carolina School of Science and Mathematics, located in Durham, is a state-funded public school that brings roughly 400 gifted 11th and 12th graders to its residential campus. The school was established in 1978 by the legislature and receives additional support from industries and foundations. Students are selected on the basis of mathematics and science aptitude and contribute to their tuition and board costs through work and service at school and in the community. Distinguished faculty and highly skilled individuals and consultants from industry and education provide an enriching atmosphere for the students.

Two governor's schools in North Carolina offer summer residential programs for gifted high school juniors and seniors. Their purpose is to help gifted young people achieve their full potential, to encourage schools to establish and improve programs for gifted students and to train teachers to teach gifted students. Governor's School West is located at Salem College in Winston-Salem; Governor's School East is at St. Andrews' Presbyterian College in Laurinburg. Four hundred students nominated by school districts participate at each campus. The schools offer a wide variety of courses, including science and mathematics.

During the summer of 1987, 600 academically talented rising juniors and seniors were involved in the Summer Ventures programs. These programs are five-week long residential workshops and are held on five university campuses in North Carolina. The specific courses vary by site, but the curriculum focuses on science, mathematics and the use of computers.

Special Populations

In 1983, eight model schools in science and mathematics were established with the intent to encourage increased enrollment of females and minorities. The program has been refunded for this year under the new title of Innovative Programs in Science and Mathematics. The Southeastern Consortium for Minorities in English is a university-

based program that works to encourage minorities and females to enroll in science and mathematics courses throughout their high school years. The North Carolina Math and Science Education Network has allocated $4,000 to encourage minorities to improve their elementary science and mathematics skills prior to enrolling in level II science and mathematics programs. The North Carolina Intervention Program for females and minorities was developed to raise the number of minorities and females completing Algebra I and to motivate these students to enroll in the highest level of science and mathematics courses. The program is funded through Title II and foundation funds. (The first 50% of Title II funds has been used to increase minority and female participation in mathematics and science.) In addition, several conferences have recently been held on the subject, and two programs focusing on females are in place (EQUALS and COMETS). Finally, the state is also involved in programs to encourage handicapped and visually impaired students to participate in more science and mathematics activities.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

There are no tests of higher order thinking skills per se, but the writing test requires higher order thinking skills to be exhibited before students can earn a high score of "3" or "4." North Carolina also reports scores on the California Achievement Test items used that are listed as higher order thinking skills items.

Assessment Content

There is a close match between the commercially developed test used in North Carolina and the curriculum; there are questions on the test measuring each goal and most objectives developed by the state. Each objective on the minimum competency test is included in the curriculum by grade 8.

Assessment Reporting

Assessment results are reported for the state, districts, schools and students. These results are made public.

State assessment results are intended to be used by schools to assist teachers in their instructional planning, to inform parents of their children's progress, to allow principals and department heads to plan curriculum and to allow for school-by-school comparison and for subgroups within the school (Chapter I students, etc.) to be compared to those same subgroups in the unit, region and state.

Assessment results are intended to be used by districts to allow curriculum supervisors to make judgments about the strengths and weaknesses of the curriculum, to allow unit-by-unit comparison and to allow subgroup comparisons among the regions of the state.

Assessment results are intended to be used by state policy makers to report to the State Board of Education on strengths and weaknesses in the curriculum, to make comparisons to national reference points, to report to the legislature and governor and to report to opinion makers (newspaper editors, etc.).

Subject Areas Assessed

The state's 10th grade minimum competency test assesses students in mathematics, reading, writing, and language arts. Students are also assessed in these subjects in grades 1, 2, 3, 6 and 8; in social studies and science in grades 3, 6 and 8; in writing in grades 6 and 8; and in algebra I and II and biology in all grades in which the subjects are taught.

TEACHERS

Teacher Recruitment and Retention

The North Carolina Prospective Teachers Scholarship Loan Program provides up to $2,000 per year to prospective teachers. Science and mathematics education undergraduates are preferred scholarship recipients. In 1986, $1.2 million was appropriated for the scholarship loan program; $1.6 million has been appropriated in 1987. A teacher recruitment office has been established in the state education agency to recruit teachers for all subjects.

Teacher Shortages

Teacher shortages are reported for both mathematics and science. (Although there is always a teacher in every classroom, they are not necessarily as qualified as might be desired.)

The state is addressing shortages through a teacher recruitment program in which each school system has a recruiter for teacher education. Additionally, a scholarship program is in place that provides prospective teachers with up to $5,000 per year for five years for continuing education. The fellowship is forgiven at a rate of $5,000 per each year spent teaching in North Carolina.

Certification Requirements

The state of North Carolina has a competency-based teacher certification program. Six semester hours are required to meet the competencies in science and mathematics for elementary certification.

Middle grade certification is offered in North Carolina and requires at least 24 semester hours in mathematics and a "concentration" (16-18 credits) of science study, including at least three hours of credit in biology, chemistry, physics and earth science.

Secondary certification requires 24 semester hours in science, including a concentration in one science, additional work in another of four major areas and 30 to 32 semester hours in mathematics. There is no requirement for a fifth year of professional study to become certified, but 15 renewal units are required every five years. However, there has been discussion of requiring a fifth year of professional education, spurred by the Carnegie report. Teachers entering the system are on a provisional certificate for the first three years and work with a mentor teacher.

Alternative Certification

During the 1986-87 school year, persons holding a bachelor's degree in science or mathematics with a minimum GPA of 2.2 and passing scores on the National Teachers Examination were eligible to apply for a six-week, teacher education summer session.

After successfully completing the summer courses, individuals are now teaching part-time in local high schools with guidance from mentor teachers. The training will terminate with a one-week seminar in the summer of 1987. The program is supported by the Science and Mathematics Education Center at East Carolina University. It is uncertain whether the program will continue in the future.

In 1985, the legislature established the Lateral Entry Program. Applicants must receive recommendations from an individual and the employing school district and must complete standard certification procedures. A college or university with a state approved teacher education program must also compare the applicant's past experiences with required certification competencies. To date, 161 people in all disciplines have taken advantage of this program.

Teacher Training

To upgrade the skills of mathematics and science teachers, the state education agency is involved in the Mathematics/Science Education Network, which is funded by the state to improve mathematics and science teaching. Its purpose is to upgrade teacher knowledge, certification requirements and general knowledge of applications of mathematics and science. The network works with local school systems to provide teachers with educational opportunities close to the school system. The network has received $750,000 for the 1986-87 school year. Title II funds are also used for teacher training programs. The division of science in North Carolina is made up of 11 people, with 3 in Raleigh and 8 others, who are involved in provision of inservice programs every day on such issues as testing, content, higher order thinking skills and implementation of the new curriculum.

Staff Development Needs

The greatest needs among science teachers are continued staff development in science process skills and higher order thinking skills (K-12) and continued staff development as it relates to specific content areas (K-6).

The greatest staff development needs among mathematics teachers are remediation techniques and use of materials such as calculators and computers.

FUNDING

Title II funds are used for staff development, workshops, attendance at conferences and tuition grants. The focus of these programs in science is primarily on content in elementary settings and method in middle levels. In mathematics, the focus is on content and methodology in grades 1-12.

The state has allocated an estimated $5.00 per student for the past three years in grades 1-12 to purchase materials and supplies for use in science and mathematics instruction. Special funds are also available under the model schools program to allow one person per county to coordinate programs in science, mathematics or computer education.

RECENT STATE REFORMS/NEW INITIATIVES

Recent state reforms include a special $5.00 per student allocation for science and mathematics materials and supplies, and a fellowship program for currently employed teachers who wish to upgrade their science and mathematics skills. Also available are

extended employment opportunities for high school mathematics teachers. These teachers can receive extended employment for six weeks in the summer to work on upgrading the curriculum, special projects, etc.

TRENDS AND ISSUES

North Carolina's biggest challenges in improving science instruction are:

1. Improving teacher salaries, incentives, recognition, working environment, and making science teaching a worthwhile career;
2. Continued staff development, teacher training and identification of needs; and
3. Physical support — equipment, labs, materials and supply.

The biggest problems faced by the state in improving mathematics instruction are:

1. Increase enrollment of minorities and females in quantitative mathematics classes;
2. Teaching of mathematics beyond arithmetic by using concrete materials, computers and calculators;
3. Increase students' knowledge of higher order thinking skills; and
4. Effective remediation programs for low-ability students to improve their performance in mathematics.

NORTH DAKOTA

CURRICULUM

Curriculum Guides

North Dakota's curriculum guidelines, developed by the state education agency, are recommended for use by school districts. The mathematics guide exists for grades K-12 and was last revised in January, 1986. A new K-6 science guide was completed during the summer of 1987.

Higher Order Thinking Skills

The emphasis on higher order thinking skills in North Dakota is cross-curricular, involving thinking skills' workshops and current research.

Time Requirements

The recommended amount of time for science instruction for grades 5 and 6 is 120 minutes per week. Two hundred minutes per week are designated for grades 7 and 8, and 250 minutes per week are recommended for grade 9. Mathematics courses in grades 9-12 are required to meet a minimum of 40 minutes per day.

Graduation Requirements

Since 1983, graduation requirements include two units in science and two units in mathematics. However, for any high school to be accredited by the Department of Public Instruction, it must offer at least once during each four-year period, four units of science and three units of mathematics. Alternative curriculum plans may be adopted by board action if approved by the Superintendent of Public Instruction.

STUDENTS

Recognition and Awards

North Dakota students participate in the West Virginia Youth Science Camp and summer programs sponsored by the Department of Energy.

Summer Institutes, Magnet and Residential Schools

No state-sponsored summer institutes, magnet or residential schools were reported.

Special Populations

No special programs to increase the participation of special populations were reported.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

Higher order thinking skills are not specifically addressed on the standardized tests used by North Dakota.

Assessment Content

The assessment content found in the standardized tests used by the state does not specifically reflect the state's curriculum guidelines.

Assessment Reporting

The state reports assessment results for students, schools and districts. These results are locally determined as to whether they will be made public, but state results are made public.

Assessment results are intended to be analyzed and compared to district and state results to determine if there are areas of weaknesses. Districts intend to use assessment results to compare district, state and national data to determine if there are areas of weakness that should be addressed. Results are intended to be used by state policy makers to compare state and national data to determine if there are areas of weakness that should be addressed.

Subject Areas Assessed

Students in grades 3, 5, 7, 9 and 11 are assessed annually in mathematics, reading and language arts. All students except those in grade 3 are assessed each year in social studies and science.

TEACHERS

Teacher Recruitment and Retention

No recent state initiatives designed to attract or retain teachers were reported.

Teacher Shortages

No teacher shortages were reported in either science or mathematics.

Certification Requirements

Elementary certification requirements vary according to the requirements of individual colleges. There is no special certification required for middle school/junior high school. Secondary school certification in science or mathematics requires a major or minor in the subject, or the equivalent. Teachers must complete four semester hours of course work each five years to maintain certification.

Alternative Certification

No alternative certification programs were reported.

Teacher Training

The state works to upgrade the skills of science and mathematics teachers through support of Title II programs, institutes and National Diffusion Network (NDN) activities.

Staff Development Needs

The greatest staff development needs among science and mathematics teachers are use of technology and upgrading teaching skills at the elementary and middle school levels.

FUNDING

Title II funds are used to provide area-cooperative inservice programs and to adopt NDN programs. No additional state monies or resources targeted for science or mathematics instruction were reported.

RECENT STATE REFORMS/NEW INITIATIVES

No recent state reforms that affect science or mathematics instruction were reported.

TRENDS AND ISSUES

The three biggest problems North Dakota faces in improving science instruction are:

1. Lack of skills of elementary teachers;
2. Lack of skills of junior high school teachers; and
3. Lack of appropriate use of technology in the classroom.

North Dakota's three biggest challenges in improving mathematics instruction are:

1. Additional training for K-8 teachers;
2. Use of manipulatives in classrooms; and
3. Use of resources other than textbooks.

OHIO

CURRICULUM

Curriculum Guides

Ohio has Minimum Standards for Elementary and Secondary Schools, including science and mathematics self-appraisal checklists developed by the State Board of Education. These are required for science and mathematics instruction and recommended for computer education instruction. In addition, secondary mathematics monographs, last revised in 1984, and elementary mathematics monographs (nearing final development) are available to provide assistance for local curriculum development activities. The Science Advisory Council and the state science consultant are in the process of writing curricular guides for science.

Higher Order Thinking Skills

Higher order thinking skills in mathematics are being addressed using inservice booklets published in 1980. A plan to address higher order skills in science is currently being devised.

Time Requirements

The state does not have time requirements for individual subjects in grades 5-8. The time required for all subject instruction is 1,100 minutes per week for grades 5 and 6 and 1,000 minutes per week for grades 7 and 8. In grade 9, 450 minutes per week are required for science instruction.

Graduation Requirements

The Ohio State Board high school graduation requirements are one unit for science and two units for mathematics to be earned in grades 9-12. These requirements are effective as of September 1987.

STUDENTS

Recognition and Awards

Academic contests provide recognition for students in mathematics. No specific programs are reported in science.

Summer Institutes, Magnet and Residential Schools

Ohio supports the Essex School for the Gifted and Talented for 150 9th-12th grade students who applied for and have received recommendations. In addition, summer institutes that offer three weeks of instruction in computers and critical thinking are available for 150 students per year.

Special Populations

Ohio has a sex equity consultant who conducts a variety of programs. The state encourages overall involvement rather than offering special programs.

STUDENT ASSESSMENT

Ohio does not currently have a state assessment program, but the State Board of Education has passed a resolution requesting the legislature to legally open the doors for such a program.

TEACHERS

Teacher Recruitment and Retention

A state loan forgiveness program is available for prospective teachers of mathematics for selected priority areas of Ohio.

Teacher Shortages

There are no reported shortages statewide, but in some locations there are shortages of mathematics teachers.

Certification Requirements

Provisional certificates at the elementary level require eight semester hours in in science (including biology and physics) and six semester hours in mathematics. Provisional certificates at the high school level (grades 7-12) require 30 semester hours of general education in a variety of areas, including science and mathematics. There are semester hour requirements for subject areas to be taught; both science and mathematics require an additional 30 semester hours.

Alternative Certification

No alternative certification programs were reported.

Teacher Training

The state employs consultants whose continuing function is to offer a variety of teacher training programs. Plans to upgrade the skills of science teachers are being reviewed.

Staff Development Needs

The greatest staff development need among science teachers is inservice to update and help teachers respond to new trends and research implementation. The greatest staff development needs among mathematics teachers are building their morale and opening up communication among themselves that will keep them professionally active and positive.

FUNDING

Title II funds are used for locally determined inservice needs. Additional funds targeted to mathematics instruction have been made available to districts. For example, a $250,000 funded general mathematics project has been initiated in the Columbus City schools.

RECENT STATE REFORMS/NEW INITIATIVES

Statewide testing of students looms as a large threat to some teachers and as a much-needed information/data instrument to others.

TRENDS AND ISSUES

The largest problem facing Ohio in improving science instruction is the lack of hands-on activities in science. State education agency staff are currently writing a resource book to help teachers implement more hands-on activities and problem solving in science.

The biggest problems Ohio faces in improving mathematics instruction are:

1. Getting consensus across the grades on intended outcomes;
2. Offering a nonremedial general mathematics alternative; and
3. Improving the junior high school program.

OKLAHOMA

CURRICULUM

Curriculum Guides

Oklahoma's Suggested Learner Outcomes for science and mathematics were developed in 1985 by a committee of classroom teachers, administrators and college or district-level supervisors. The use of these guides is recommended.

Higher Order Thinking Skills

The State Superintendent of Public Instruction has encouraged state educators to teach higher order thinking skills. In addition, the statewide student assessment program measures higher order thinking skills, and a curriculum guide on critical thinking skills is being developed for use by state educators. Inservice programs, staff development and methods classes in preservice programs and universities also help teachers to focus on higher order thinking skills.

Time Requirements

There are no guidelines regarding the amount of time to be spent on science instruction in grades 1-6. Two hundred and twenty-five minutes per week of science instruction are recommended for grades 7-9. Students enrolled in science in grades 9-12 spend 45-55 minutes of science per day for two years to earn graduation credit. The state recommends that students in grades 1-8 receive 300 minutes per week in mathematics instruction.

Graduation Requirements

Effective in 1987, students must earn two units in science and two units in mathematics to graduate from high school. Effective in 1988, two units of laboratory science will be required for graduation.

STUDENTS

Recognition and Awards

Oklahoma's recognition and award programs include the Oklahoma Junior Academy of Science for students in grades 7-12. It is sponsored by the state education agency, corporations and universities. The Oklahoma Science and Engineering Fair is also for students in grades 7-12. The state's Invention Convention, sponsored by the state education agency and the Department of Commerce, is for students in grades K-12. Elementary science fairs are arranged at the local level. High Flight is an aerospace workshop, sponsored by the Oklahoma Aeronautic's Commission, in which two high school students from each of the state's 11 regions participate. In addition, the state superintendent recognizes those students who achieve excellence in science-related competitions and also recognizes teachers of those students. Oklahoma students also participate in Math Counts, the West Virginia Youth Science Camp and U.S. Department of Energy programs.

Summer Institutes, Magnet and Residential Schools

Oklahoma is in the planning stages (site selection) for the new Oklahoma High School for Science and Mathematics. Legislation for the school passed in 1983 and funds for planning have been allocated. The school is designed to serve approximately 250 high school juniors and seniors. Two magnet high schools for science are in existence in the state — the Northeast High School Science Center is located in Oklahoma City, and the Booker T. Washington High School is located in Tulsa. These schools are funded through a combination of state and local monies.

Summer institute programs include the Oklahoma High School Institute at Oklahoma University Biological Station, an eight-week course in field biology. Students apply and are selected on the basis of their GPA and course work. Fifteen students are eligible to attend each summer. The Fleming School Program, funded by the Oklahoma Medical Research Foundation, selects 10 students to conduct biomedical research for eight weeks at the Oklahoma University Medical school.

Special Populations

The Oklahoma High School for Science and Mathematics that is under development will target gifted students and will make efforts to include minorities and females, as do the two magnet schools identified above.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

Higher order thinking skills test data are reported to schools on their regular test reports at the individual, class (grade 3 only), building and district levels. These data are aggregated from all subtest items that measure higher order thinking skills. The percentage of total correct items (raw score) is converted to stanine and then reported as "LOW" (stanines 1-3); "AVERAGE" (stanines 4-6); or "HIGH" (stanines 7-9) based on the stanine grouping in which each student's or group's total score was found to be. Post-test inservice is conducted to aid in interpretation and use of all test scores, with practical application at the classroom, grade, building, and district level. Materials are currently being developed to provide specific strategies and activities for teaching higher order thinking skills. These materials will be distributed during inservices at each local school level.

Assessment Content

Upon receiving proposals in response to its Request for Proposals (RFP), the state of Oklahoma conducted a rigorous evaluation/selection process involving 80 teachers and school administrators from throughout the state. As part of the requirement for responding to the RFP, testing companies had to supply evidence of the "matching" of their test items in all subtests of the achievement test with the Oklahoma Suggested Learner Outcomes. During the evaluation process, the teacher/administrator committees — using each test companies' correlation — read each test item, read the corresponding learner outcomes, and validated the degree of measurement match, which was one of the major criteria for selection of a test to be administered. Measurement results on each of the outcomes are provided to schools at the individual student, class (grade 3 only), building and school district levels. These are being used to examine and improve programs.

Assessment Reporting

Assessment results are reported for the state, districts, schools and students. The state education agency makes public normative district-level data on each of the subtests and the weighted averages of (1) reading, language arts and mathematics; and (2) all individual subtest averages as well as the weighted average of all combined subtests.

Schools and districts use state assessment results to determine basic strengths and weaknesses at the individual student, class (grade 3 only), building and school district levels. This information is reflected in each school district's legislatively mandated Five-Year Plan for School Improvement. In this plan, school districts must use the state test results to indicate "Where we are NOW, "to determine where they want to be in terms of instructional programs and scores FIVE YEARS FROM NOW, and to list specific objectives for ways in which they are going to accomplish their goals and objectives. The Five-Year Plan for School Improvement was legislated in 1986. The first set of plans was turned in to and checked by the state education agency on January 1, 1987. The state education agency inservice personnel use these plans as an aid in determining ways in which the Department can offer concrete aid to schools. The Five-Year Plan must come from the district as a whole, but building-level data can be utilized. Inservice is offered at both the school district and individual building levels to any size group of teachers and/or administrators.

State education policy makers are intended to use the assessment results to review state-level data and to determine major strengths and weaknesses toward the goal of improving programs statewide when possible. As stated above, the state education agency uses district- and building-level data (as well as self-stated goals from schools) to identify areas of need in the schools.

Subject Areas Assessed

Each student in grades 3, 7 and 10 is assessed annually in mathematics, reading, social studies, language arts and science. Tenth graders were also assessed in writing in 1987. In 1988, both 7th graders and 8th graders will be assessed in writing.

TEACHERS

Teacher Recruitment and Retention

In 1985, the Future Teachers Scholarship Program was established by the legislature. Scholarship monies are dispersed to institutions of higher education that make the award decisions. Outstanding students, who have intentions of teaching in a critical shortage area (including mathematics and science) and who have less than 90 credit hours may receive up to $1,000 per year; students with more than 90 hours may receive up to $1,500 per year.

The State Regents for Higher Education recently initiated a forgivable loan program for students in science, mathematics and foreign language. In 1986, the legislature allocated $200,000 for the program. Scholarship recipients must agree to teach in a shortage area in one of the state's public schools for one year for each year of aid received.

Both programs were funded again for 1987.

Teacher Shortages

Teacher shortages are reported in both science and mathematics. The Future Teachers Scholarship Program and forgivable loan program assist in alleviating these shortages by encouraging students to enter science and mathematics teaching.

Certification Requirements

The Elementary School Certificate (grades K-8) requires 50 semester hours in general education, including mathematics and both physical and biological sciences. The Secondary School Certificate (grades 7-12) has the same general education requirements as the Elementary School Certificate; however, it also has specialized area education requirements.

A high school science teacher must complete a minimum of 40 semester hours of science instruction. Academic preparation must include a minimum of 10 semester hours of biology, a minimum of 10 semester hours of chemistry, a minimum of three semester hours of earth science and a minimum of three semester hours of anatomy or physiology. Specific course work requirements are listed for subject endorsements in biology, chemistry, physics, physical science, anatomy/physiology, botany, zoology, earth science and computer applications.

A high school mathematics teacher must complete a minimum of 40 semester hours of mathematics instruction with at least 24 semester hours at a level above intermediate algebra. Academic preparation in computer science/computer applications, statistics and other areas, which may include mathematics, applied mathematics, computer science/computer applications, physics and statistics, is required. Specific course work requirements are listed for subject endorsements in algebra, geometry, trigonometry, analysis, calculus, computer science/computer applications and statistics.

Teachers completing an approved teacher education program may receive a license to teach for one year. During the first year of teaching, they participate in the entry-year assistance program. After successful completion of the entry year, they may apply to receive a standard teaching certificate if they have passed the evaluation and examination components of the certification requirements.

Alternative Certification

In 1986, the Alternative Certification Plan was established by the State Board of Education through which temporary certificates may be granted if they are requested by the employing district. These teachers must receive supervision throughout the year, meet admission standards to a teacher education program and complete all required education courses. Reportedly, very few individuals have availed themselves of this opportunity, although it is still in place.

Teacher Training

In order to upgrade the skills of teachers, the Professional Standards Board has revised certification requirements. Staff development workshops are provided by the state education agencies science and mathematics specialists in local districts upon request.

Staff Development Needs

The greatest staff development need among science teachers is training in hands-on, inquiry approach to teaching science. The greatest staff development need among mathematics teachers are methods to improve student achievement.

FUNDING

Title II funds are spent on college tuition for teachers to continue their education, on textbooks and on substitute teachers. Funds are also allocated to science and mathematics materials and equipment and to allow the state education agency to plan multidistrict inservice and staff development programs.

RECENT STATE REFORMS/NEW INITIATIVES

Recent education reform includes an increase in high school graduation requirements and new college entrance requirements.

TRENDS AND ISSUES

The biggest problems facing Oklahoma in improving science and mathematics instruction are limited funds to hire teachers, purchase textbooks and other materials and build and/or update laboratory facilities.

OREGON

CURRICULUM

Curriculum Guides

The Oregon Framework, which is outcome based, includes required goals in science and mathematics for grades 3, 5, 8 and 11 and suggested goals for all grades, K-12. The framework was developed by a widely representative committee of teachers, specialists and college instructors. Currently, changes are being made by 14 instructional regions using Title II funds. After the preliminary revisions are made, 100 other people in the state will review them and make recommendations. Thus far, 32 Essential Learning Skills have been identified in science, and teachers must address 20 of the 32 in their courses. The Essential Learning Skills state, for example, that students will be able to: (1) identify main ideas, supporting details, facts and opinions found in an oral, written and visual format; (2) use instructional materials as a basis for gaining knowledge and basic comprehension; (3) generate and test interpretations, explanations, predictions and hypotheses; (4) reflect upon and improve their own reasoning; and (5) make reasoned evaluations.

Higher Order Thinking Skills

Higher order thinking skills, such as problem solving and reasoning, are included in the Essential Learning Skills.

Time Requirements

The state recommends that the following amount of time be spent on science instruction: 150 minutes per week for grades 5 and 6; 200 minutes per week for grades 7 and 8; 225 minutes per week for grade 9. These range between 10% and 20% of the instructional day. There are no specific time recommendations for science instruction for grades 10-12 other than the graduation requirements of two units. In the opinion of one respondent, there should be adjustments made in the time allowed for science instruction since teachers now have to focus on 20 of the 32 essential learning skills.

For grades K-8, the state recommends that 15 percent of the instructional day be spent on mathematics. For grades 9-12, the state does not require or recommend daily mathematics, but students must meet the minimum graduation requirements of two units.

Graduation Requirements

Beginning with the graduating class of 1988, Oregon State Board regulations require two units of science and two units of mathematics. Local districts may increase the number of units of credit required for graduation. Students must demonstrate competence in mathematics. Proficiency is recorded on high school transcripts.

STUDENTS

Recognition and Awards

Recognition programs for students in science and mathematics are mainly supported at the college/university, local and national levels. For instance, students from Oregon participate in the West Virginia National Youth Science Camp, the Science Olympiad and the International Engineering and Science Fair.

Summer Institutes, Magnet and Residential Schools

The Oregon Graduate Center Saturday Academy, supported by the state of Oregon and private foundations, is for students in grades 1-12 with a special interest in science. Selection of students is based on outstanding academic performance.

The Oregon Summer Science Experience, held at the University of Oregon, is a two- to three-week summer program for high school sophomores and juniors that focuses on chemistry, physics and earth and life sciences. Students must apply to the program. Selected students pay their own expenses but may receive partial scholarships.

Ten of the state's most outstanding high school juniors and seniors are selected to participate in the Oregon Regional Primate Center, located in Beaverton, Oregon, where they conduct research in life science. Selected students are awarded scholarships to pay for their expenses.

There are no similar state-supported programs for students in mathematics.

Special Populations

The state, in cooperation with the Native American Science Education Association, is in the process of organizing the Oregon Multi-Cultural Science Association to promote multi-cultural studies in science and mathematics. For example, there will be an emphasis on teaching biology from a Native American perspective. This program is being funded by Federal Chapter I monies. The Native American Science Education Association is also trying to build support for minority education through Title II funds.

An autonomous section of the State Department of Education that deals strictly with gifted students funds the Olympics of the Mind, a program for gifted junior high and high school students.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

Components of thinking skills are incorporated in each test. The writing test includes Ideas and Content and Organization; reading includes Implied Meanings, Accuracy of Information and Reasoned Evaluations; and mathematics includes Mathematical Relationships and Problem Solving.

Assessment Content

Oregon's assessment content is designed to assess the Essential Learning Skills. The State Board of Education and Department of Education require local districts to establish goal-based instructional programs in science as well as in other curriculum areas and to evaluate these programs using student achievement data as one element in the evaluation. This requirement has been the primary motivation for districts in the state to build curriculum-aligned tests in science. The department has supported these efforts by helping to build test item banks and supporting workshops on both test development and the utilization of test results for program improvement.

During the last two years the Department of Education has begun to specify a core part of the goal-based programs that local districts must teach. This will provide more direction to districts, which they have requested.

Assessment Reporting

Assessment results are reported for the state, schools and students. Results for the state are made public.

Schools primarily use assessment results for program improvement. Based on the results, schools can determine their programs' strengths and weaknesses. Districts use assessment results in the same way.

The state has two interests when analyzing test results. One is to look at strengths and weaknesses to focus state curriculum and staff development efforts. The other is to report the status of achievement in the state to serve as a surveillance function.

Subject Areas Assessed

During the 1987 school year, a sample of students in grade 8 will be tested in reading, writing and mathematics. The assessment schedule for 1988-90 is uncertain because of the legislative cuts in department funds.

TEACHERS

Teacher Recruitment and Retention

There have been no recent initiatives implemented by the state to attract or retain science or mathematics teachers.

Teacher Shortages

The state of Oregon has teacher shortages in both science and mathematics because many teachers are teaching without proper endorsement. There is a state law that allows teachers to teach up to two class periods of science (or any other subject) per day regardless of their endorsement areas. For example, in 1984 the state had teachers endorsed in 19 different subject areas teaching science. The only measure the state department can take to address these shortages is to encourage teachers to earn the proper endorsement in their assigned subject areas. However, most teachers won't undertake the additional schooling to become fully endorsed.

Certification Requirements

Oregon offers a Basic Teaching Certificate (valid three years) and a Standard Teaching Certificate (valid five years). The number of quarter hours required for subject matter endorsement in mathematics for the Basic Teaching Certificate is 21 in basic mathematics and 42 in advanced mathematics. The Standard Teaching Certificate requires 18 additional quarter hours in advanced mathematics. The number of quarter hours required for subject matter endorsement in science for the Basic Teaching Certificate is 45 (including 24 quarter hours in the subject to be taught and 18 in biology, physical and earth sciences preparation). The Standard Teaching Certificate requires an additional 15 quarter hours of course work.

The state does not yet require a fifth year of professional education beyond the initial four years to become certified; however, there is a strong move to adopt such a requirement.

Alternative Certification

The state is currently phasing in a program to award subject matter endorsements based on National Teachers Examination subject area test scores. People accepted under this program must also complete a rigorous summer training program and all necessary course work for full endorsement within a specified time period.

Teacher Training

To upgrade the skills of its science and mathematics teachers, the state works with colleges in coordinating their teacher preparation programs to ensure that they include statewide required goals. There are also several Title II funded inservice programs and staff development conferences sponsored by professional organizations.

Staff Development Needs

One of the greatest staff development needs among science teachers is a more hands-on approach to teaching science. In addition, goals for the science program need to be established, a curriculum based on those goals needs to be developed and an assessment program aligned with the goals and the curriculum needs to be implemented.

Staff development needs among mathematics teachers include emphasizing the use of manipulatives, problem solving, statistics and probability (K-12) and geometry (K-12).

FUNDING

All Title II funded projects are related to staff development for some curricular area in grades K-12. Many districts, and colleges in several cases, are working together on cooperative projects by pooling their Title II allocations.

The legislature has not allocated any new money to the state education agency; in fact, the State Department of Education budget is being cut. This budget cut will eliminate the State Textbook Commission and the staff evaluation and assessment program, and retiring employees will not be replaced.

RECENT STATE REFORMS/NEW INITIATIVES

Oregon's new emphasis on curriculum development and assessment are serving as a catalyst for updating the mathematics program. However, the budget cuts will hinder any attempts to improve the state's education system.

TRENDS AND ISSUES

The three biggest problems the state of Oregon faces in improving science instruction are the following.

1. Much greater support needs to be given to teachers in helping them understand how learners learn. Teachers also need to understand the major concepts of science and how to teach them instead of only facts.
2. As noted previously, the state's education system needs more financial support in all areas.
3. The government and general public need to become more aware of the importance of science instruction and education. As one survey respondent noted, "If these groups had as much interest in science as they do in athletics, the science program would be pretty well off."

Currently, there is a major push in the state that is focused on determining how to establish a good K-12 science program, how to help teachers and students deal with a concept-based program and how to assess progress.

The three biggest problems the state faces in improving mathematics instruction are:

1. An outdated curriculum;
2. Research findings about how students learn being ignored; and
3. The recent de-emphasis of teacher preparation.

The state is trying to solve all three of these problems and is making some impact on the first two; they are still losing ground on the third.

PENNSYLVANIA

CURRICULUM

Curriculum Guides

A select committee, under the leadership of the Pennsylvania state education agency, recently developed and subjected to field review Competency Continuums recommended for use in grades K-6 and 7-12 science.

The state education agency has begun work on an elementary (K-3) mathematics curriculum framework (preliminary draft was due in July 1987) and plans to work on a variation of this framework for grades 4-6 in 1988. As of June 1985, a Planned Course Format has been recommended for non-college-bound students. This course format, developed by a broad cross-section of people around the state (including college professors in elementary education, mathematics teachers and supervisors), outlines six strands one should expect to find in these certain courses. Course frameworks are also available in algebra, geometry, algebra II and trigonometry.

Higher Order Thinking Skills

Higher order thinking skills in science are emphasized at all levels (this is one of Pennsylvania's 12 Goals of Quality Education). The emphasis is evident primarily in preservice and inservice programs. The New Mathematics Curriculum Framework under development for grades K-3 will stress understanding, problem solving and improvement of higher order thinking skills.

Time Requirements

Pennsylvania recommends that students receive 30 minutes of science instruction per week in grades 5 and 6, and 300 minutes in grades 7, 8 and 9, including recommended laboratories.

There are no requirements or recommendations regarding the quantity of mathematics instruction students should receive at the elementary level; however, in grades 7 and 8, the state requires at least two planned mathematics courses and recommends that students receive 200 minutes of mathematics instruction per week. Students in grades 9-12 are required to receive at least 200 minutes per week of mathematics instruction.

Graduation Requirements

In Pennsylvania, local school districts arrange planned courses that must conform with requirements of the State Board of Education. Beginning with the class of 1989, three units of science and three units of mathematics will be required. (School districts will be required to offer at least five planned science and mathematics courses in grades 7-12, and students must take at least three planned science and mathematics courses in grades 9-12.)

STUDENTS

Recognition and Awards

State-sponsored recognition and award programs in science include: the Pennsylvania Governor's School for the Sciences, the Pennsylvania Honors Testing Program (Honors Diploma and scholarships) and the McAuliffe/Resnik Scholarships (two scholarships at $10,000 each).

Recognition and award programs in mathematics include sponsorship of mathematics contests each year and a 1987 program sponsored by the Pennsylvania Council of Teachers in Mathematics to recognize two high school students' outstanding achievements in mathematics. Pennsylvania students participate in the Math Counts Program in several grade levels, and a number of universities have their own mathematics contests. The Central Pennsylvania Math League sponsors competitions that allow high school seniors to take an honors test in four areas and be awarded an honors diploma in addition to the regular diploma. If the legislature approves, there may be scholarships associated with the honors degree.

Summer Institutes, Magnet and Residential Schools

Pennsylvania Governor's School for the Sciences was established in 1983 at Carnegie-Mellon University with state funding and support from Pennsylvania foundations. In 1983, the school accommodated 90 students about to enter their junior and senior years in high school. Future programs will attempt to expand the number of student participants. The school emphasizes science, mathematics and technology, and offers guest lectures by international speakers. Students apply to an intermediate unit that forwards to the state education agency the top 20% of applicants (approximately 200-250). The state education agency then selects the successful candidates on the basis of SAT scores, teacher ratings and recommendations, counselor ratings, GPA, class rank, number and level of mathematics courses, awards and essays of why they want to go to the governor's school.

There is also a Pennsylvania Governor's School for Agriculture at Pennsylvania State University, which focuses primarily on the sciences (hoping to shed the cows and plows image). The selection criteria are similar to those above.

There are several Intermediate Units operating schools for talented students in science and mathematics.

The Pennsylvania Governor's School for the Arts, located at Bucknell University, has been operational since the mid-1970s. Students submit samples of their work to the Intermediate Unit; successful candidates are interviewed and, if appropriate, must audition.

Special Populations

Funding administered under Title II encourages programs to serve special student populations such as women and minorities. A series of workshops were presented in 1987 on mathematics for minority students.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

An analytical thinking component is included in the assessment battery. The Educational Quality Assessment Program (EQA) includes a measure of analytical thinking that is used in reference to assess higher order thinking skills.

Assessment Content

Advisory committees whose members are knowledgable about curriculum and objectives for their respective subject areas help coordinate assessment content within the state's curriculum.

Assessment Reporting

Assessment results for the Educational Quality Assessment (EQA) are reported for the state, districts and schools. Only the state results are made public.

Assessment results for the Testing for Essential Learning and Literacy Skills (TELLS) are reported for the state, districts and students. Results for the state and districts are made public.

The TELLS program is intended to identify students who have deficiencies in reading and/or mathematics and to provide funds for remedial assistance for them. The EQA program is designed to provide information for school directors and administrators so they can make changes in programs if they feel revisions are needed.

Subjects Assessed

TELLS - all students not exempted in grades 3, 5 and 8 are assessed in mathematics and reading every year.

EQA - students in grades 4, 6, 7, 9 and 11 are annually assessed in mathematics, communication skills, citizenship, science/technology, arts and humanities, environmental knowledge, self-concept in school, health and safety practices, analytical thinking, family living, knowledge of the world of work, self-esteem and understanding others.

TEACHERS

Teacher Recruitment and Retention

Forgivable loans are available to undergraduate science and mathematics education majors. Funds have also been allocated to retrain teachers in science and math. In addition, the Pennsylvania Higher Education Assistance Agency, a public agency that almost operates privately, distributes financial aid to students.

Teacher Shortages

No statewide teacher shortages are reported at this time (retirement, however, will take a lot of teachers from the system over the next few years). There are not enough substitute mathematics teachers, and there is a growing shortage of physics and chemistry teachers.

Teacher shortages are addressed through loan programs, teacher retraining for certification in science and mathematics and an emergency certification program.

Certification Requirements

For all subject areas and at all grade levels, students must complete an approved program of study. A certificate is issued after the student passes a professional entry exam and finishes an induction year.

Teachers are required to take continuing education courses to remain certified.

There are a few institutions (Allegheny College, for example) with a five-year program, and others are looking into it. This program involves a four-year liberal arts program and a fifth year of education courses.

Alternative Certification

Pennsylvania has an Emergency Certification — Intern Program for those with a bachelor's degree in science or mathematics who wish to teach while they complete the education credits necessary to receive full certification. In addition, Act 97, Waiver of Certification applies to teachers who have been furloughed in one area with course work in another. The teacher must still pursue additional course work to become fully certified.

Teacher Training

To upgrade the skills of all teachers, Pennsylvania will require teachers to obtain six continuing education credits every five years to renew their certification. Also, an inservice grant program is in place to encourage teachers to continue their education.

Staff Development Needs

The greatest staff development need among science teachers is information on techniques, motivation and content. Within the area of mathematics, there has been a marked shift in emphasis in the 1980s toward higher order thinking skills combined with an infusion of technology. Not all teachers are keeping abreast of these innovations (only 5-10% of teachers are participating in statewide workshops). All teachers need to be informed of new teaching methods in mathematics.

FUNDING

Title II funds are used for a variety of purposes, including inservice programs in science and mathematics retraining seminars, workshops to upgrade skills and travel expenses associated with sending teachers to state or national meetings. Some additional state monies targeted to science instruction have been made available to districts.

RECENT STATE REFORMS/NEW INITIATIVES

Recent state reforms include an increase in graduation requirements (science and mathematics have increased to three units each). The business education community, however, felt slighted by the requirements and successfully lobbied to permit accounting and business mathematics be counted toward mathematics credit for graduation (which tends to frustrate the impact of the requirement). Additionally, the reform is not content specific, meaning that a student could take any level of science or mathematics and meet the requirement.

TRENDS AND ISSUES

The three biggest problems Pennsylvania faces in improving science instruction are:

1. Adequate science programs for general students;
2. Interface of science, technology and society; and
3. Upgrading elementary science.

The biggest problems in improving mathematics instruction are:

1. Lack of recognition of mathematics and need for improvement of mathematics instruction;
2. Lack of involvement in mathematics among elementary teachers; and
3. Not reaching enough teachers in the state due to limited state staff and funds.

RHODE ISLAND

CURRICULUM

Curriculum Guides

The State Department of Education recently produced a recommended outcome-based course outline for K-12 mathematics. There are no curriculum guides for science, but the state has established education standards in science (the state-mandated Basic Education Program requires course work in K-12 science, but curriculum is left to local education agency development).

Higher Order Thinking Skills

Higher order thinking skills are reportedly emphasized in both science and mathematics.

Time Requirements

Rhode Island does not require or recommend specific amounts of time to be spent in mathematics or science instruction. However, at the secondary level, Carnegie units of 200 minutes per week is required for graduation.

Graduation Requirements

Minimum course requirements mandated by the Rhode Island State Board of Education for the career-bound diploma are two units of mathematics and two units of science. For the college-bound diploma three units of mathematics, two units of laboratory science and one-half unit of computer literacy are required.

STUDENTS

Recognition and Awards

At the junior and senior high levels school-sponsored science fairs are used to pick school candidates for the state science fair. In addition, a voluntary merit recognition program is offered to high school seniors in a variety of subject areas. There are recognition programs for students in mathematics at all levels (system wide, individual buildings and statewide). One example is participation in the Math Counts Program. Science recognition programs are primarily school-sponsored science fair type activities.

Summer Institutes, Magnet and Residential Schools

The city of Providence has a science magnet school. There are state-supported summer institutes for high school students in mathematics. Selection is competitive and 50 students participate in a six-week program that offers courses with either an advanced or remedial focus.

Special Populations

The state Special Education Regulations require that all special education students be integrated into regular classrooms where appropriate.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

The Metropolitan Achievement Test has a higher order thinking skills subscore.

Assessment Content

Health testing is coordinated with instructional objectives of the health curriculum guide. There is not an explicit state curriculum in physical education. In reading, language, mathematics and writing, the match between testing and desired curricular objectives is under study.

Assessment Reporting

Assessment results are reported for the state, districts, schools and students. State and district results are made public. If school results are requested, districts have school assessment results available.

Subjects Assessed

Students in grades 3, 6, 8 and 10 are annually assessed in reading, language arts, mathematics, writing (3rd graders only) and health and fitness.

TEACHERS

Teacher Recruitment and Retention

There have been no recent initiatives to attract or retain science or mathematics teachers.

Teacher Shortages

Rhode Island currently has no teacher shortages.

Certification Requirements

The Secondary Certificate (grades 7-12) requires 30 semester hours of academic course work in the areas of general mathematics, general science (including six hours in biology, physics and chemistry). Biology, chemistry and physics require 30 semester hours each of academic course work.

A master's degree is required for teachers to receive life certification.

Alternative Certification

Rhode Island does not support an alternative certification program.

Teacher Training

To upgrade the skills of science and mathematics teachers, the state provides monies for inservice and ongoing workshops as requested by individuals or districts.

Staff Development Needs

The greatest need among science teachers, especially at the elementary level is to make existing staff more comfortable teaching the latest, updated concepts. Mathematics teachers generally need to upgrade and maintain their skills.

FUNDING

Districts are using Title II funds to upgrade programs, purchase textbooks, media materials, etc. Additional state monies have been made available to establish the Rhode Island School Staff Institute.

RECENT STATE REFORMS/NEW INITIATIVES

New state reforms include statewide testing with published results, provision of additional state monies, statewide reports identifying deficiencies and the mandated Basic Education Program.

TRENDS AND ISSUES

The biggest problems the state of Rhode Island faces in improving science instruction are:

1. Weak elementary science instruction;
2. Sequencing of secondary courses; and
3. Content of specific courses.

The biggest problems in improving mathematics instruction are:

1. Sequencing at the secondary level;
2. Determining exact content of secondary courses; and
3. Upgrading and maintaining skill levels of staff.

SOUTH CAROLINA

CURRICULUM

Curriculum Guides

South Carolina recommends the use of a state education agency developed Outline of High School Credit Courses. Teachers with experience in science content areas and a science consultant developed a topical outline for grades 9-12 that was last revised in 1985. State law requires the teaching and testing of the Basic Skills Objectives, developed by the Office of Research. Students in grades 1-12 not meeting the standards must be provided with remediation.

Higher Order Thinking Skills

Higher order thinking skills in science are being emphasized through a video tape under development. In addition, teacher training courses, funded by the state, are specifically designed to help middle/high school teachers become better problem solvers and better teachers of problem solving. The SAT-M Improvement Project, developed by the state education agency, is designed to improve students' problem solving and thinking skills through practice.

Time Requirements

State guidelines require 175 minutes per week for science instruction in grades 5 and 6, 200 minutes per week for grades 7 and 8 and 250 minutes per week for grade 9. Some classes in grades 6, 7 and 8 exceed these recommendations.

Guidelines for mathematics instruction require 225 minutes per week for students in grades 1-3 and 250 minutes per week for students in grades 4-12.

Graduation Requirements

As of the 1986-87 academic year, a minimum of two units in science and three units must be earned in mathematics (with a total requirement of 20 units for graduation). One unit of computer science (if approved by the state department for this purpose) can be counted toward the mathematics requirement. Students who earn one science unit and six or more units in a specific occupational service area will be considered to have met the science requirement. Vocational programs operating on a 3-2-1 schedule can count prevocational education as one of the six required units. Passage of the Basic Skills Assessment Program Exit Examination in the areas of reading, writing and mathematics will become a graduation requirement in 1990.

STUDENTS

Recognition and Awards

Each year two South Carolina students are eligible to participate in the West Virginia National Youth Science Camp, and four students are chosen to visit famous laboratories; their visits are sponsored by the U.S. Department of Energy.

Summer Institutes, Magnet and Residential Schools

The state supports the South Carolina Governor's School in Charleston and the South Carolina Governor's School of the Arts in Greenville. Approximately 250 students are chosen to attend each school year (at the end of the 10th or 11th grade) on the basis of their academic achievements (including grades and test scores) or on their demonstrated abilities to function at high-performance levels in one of the fine arts areas.

Special Populations

No specific programs to increase participation of special populations were reported.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

Under the Basic Skills Assessment in reading, South Carolina assesses contextual word meaning, inferred main idea, making comparisons, determining cause and effect, drawing conclusions, predicting outcomes, structural elements, rhetorical devices and critical analysis at all grade levels.

In the South Carolina Assessment, several higher order skills are covered in the objectives of geometry, measurement and problem solving that are assessed in grades 1, 2, 3, 6, 8 and 10.

Assessment Content

South Carolina developed a set of statewide educational objectives with the input of 18,000 teachers and the public. The objectives were disseminated to all teachers, along with the South Carolina Word Test and the Teaching and Testing Our Basic Skills document (T & T). The T & T provides instructional activities, the skills and content to be taught and assessed, activities for developing test items and sample test items.

Assessment Reporting

The state reports assessment results for students, schools and districts. School results are made public on the local school level at their option; and district and state results are made public through the state department.

State assessment results for the Basic Skills Assessment Program are intended to be used by schools and districts to provide remedial assistance to students in need of such assistance. Instructional improvement, high school diploma credentialing and grade level promotion are additional uses of the test results. The South Carolina norm-referenced test is used for remedial/compensatory funding and for comparing the state's performance to the national sample or normative group.

The state uses the Basic Skills Assessment data to determine remedial/compensatory funding, to measure student progress in meeting the instrument's objectives, to certify students for the high school diploma, to monitor the grade level promotion criteria and its effect and to assess programmatic modifications needed and funding requirements.

Subjects Assessed

The Basic Skills Assessment is taken each year by students in grades 1, 2, 3, 6, 8 and 10 in mathematics and reading; grades 6, 8 and 10 are assessed in writing, and grades 3, 6 and 8 are assessed in science.

The South Carolina Assessment (using the Comprehensive Test of Basic Skills/U — CTBS/U instrument) annually measures students in grades 4, 5, 7, 9 and 11 in mathematics, reading, social studies, language arts, science, reference skills and spelling.

TEACHERS

Teacher Recruitment and Retention

In 1984, the legislature established the Teacher Loan Program. Students who are state residents and who plan to teach in a critical shortage subject area or rural area are eligible to apply for loans under this program. Loans are forgiven at a rate of 20% for each year of teaching in a South Carolina public school. The appropriation for 1986-87 was $2.5 million.

Teacher Shortages

South Carolina reports shortages of well-qualified teachers in both science and mathematics. Steps taken to address these shortages include an Alternative Certification Program in Science and Mathematics, a new certification area for general mathematics in grades 7-12 and "Promoting Teaching as a Career" (for all subjects).

Certification Requirements

Initial certification is possible by completing a State Board of Education approved teacher training program from South Carolina or another state. An application also must present the required teaching area examination score. As an alternative to the approved program route, an applicant may qualify for initial certification by completing a sequence of specific course requirements approved by the South Carolina State Board of Education. Following this approach, elementary education certification requires 12 semester hours in biological and physical science and six semester hours in mathematics. To qualify for certification at the middle school level, a reading course and an organization/curriculum course are required. In addition, 15 semester hours in specific mathematics courses and an acceptable score on the National Teachers Subject Area Examination in Mathematics are required for certification in general mathematics. Twenty-four semester hours in specific science training required for initial secondary certification in a specific science field includes 12 semester hours in one area such as biology, chemistry or physics. The appropriate National Teachers Subject Examination in the specialization area is also required. In terms of certificate classifications, teachers may be issued credentials at the following levels: bachelor's, bachelor's plus 18 graduate hours, master's, master's plus 30 graduate hours and doctorate.

Alternative Certification

The Alternative Certification Program in science and mathematics allows college graduates with degrees in mathematics or any of the natural sciences or library science who have passed the required National Teachers Examination to be issued a conditional

certificate to teach in a South Carolina public school. Over a two- to three-year period, these individuals pursue a certification program conducted at Winthrop College, which consists of orientation to and methodology of teaching, along with certain other graduate-level course work. Between 1984 and 1987, approximately 260 individuals qualified for this program and are now in various stages of completion. A full, professional certificate is issued to an individual following completion of the alternative certification requirements.

Teacher Training

A state appropriation of $1 million per year is available for training science, mathematics and computer science teachers. There have been 50-60 science courses offered each year from 1982 to 1986; and for 1986-87, 52 mathematics courses were funded at a cost of $258,000. State funds also support special summer institutes to improve teachers' knowledge of content and methodology appropriate for applied calculus instruction.

Staff Development Needs

The greatest staff development need among science teachers is revision of teacher certification for science teachers; earth science teachers need special attention, as this group is underprepared to teach geology, astronomy, meteorology and oceanography. Elementary science is another area of staff development need, and money is needed for hands-on material. In mathematics, the greatest staff development need is training in problem solving.

FUNDING

Title II funds are used by districts to support staff development, development of curriculum guides and activity modules and teacher attendance at professional meetings in both science and mathematics. State education agency funds are used to conduct an Elementary Science Leadership Program for intense training of selected educators from school districts as well as for special activities to improve instruction in problem solving and in certain other basic skills requirements in mathematics.

RECENT STATE REFORMS/NEW INITIATIVES

The addition of science to the Basic Skills Assessment Program has increased the interest in science instruction on the elementary level. A baseline science test was given in grades 3, 6 and 8 beginning in the 1986-87 school year.

TRENDS AND ISSUES

The biggest problems South Carolina faces in improving science instruction are:

1. Revision of teacher certification is needed (no action currently being taken);
2. Teacher training must be updated (Critical Needs funding has been made available);
3. More funds are needed for science materials (a special program was funded for one year only); and

4. Elementary science leaders need to be developed for each elementary school (this was addressed with a program during the summer of 1987 at three colleges in South Carolina).

The biggest problems in improving mathematics instruction are being addressed through programs already under way to improve teacher competency and student learning at all levels.

SOUTH DAKOTA

CURRICULUM

Curriculum Guides

A statewide task force comprised of South Dakota teachers and the state science director developed a recommended framework for curriculum development in 1980 and a science curriculum guide in 1982.

Recommended curriculum guidelines for K-12 mathematics (also developed by teachers from all levels, including special education teachers) are available for use by the district's local curriculum committees. These were last revised in January 1981.

Higher Order Thinking Skills

At this time, South Dakota is considering integrating higher order thinking skills into the curriculum. The inclusion of higher order thinking skills in the language arts curriculum was investigated by one of the state's school cooperatives during the summer of 1986.

Time Requirements

There are no time requirements for science or mathematics beyond the time that is required to meet high school graduation requirements.

Graduation Requirements

Requirements for the graduating class of 1989 in South Dakota include two units of laboratory science, two units of mathematics and one-half unit of laboratory computer studies.

STUDENTS

Recognition and Awards

South Dakota has many mathematics contests, including those sponsored by the University of South Dakota (for grades 7-12), the Dakota State College (grades 9-12), Northern State College (grades 7-12), the South Dakota School of Mines and Technology (grades 9-12), South Dakota State University (grades 9-12), Math Counts (for junior high school students) and the High School Mathematics Examination.

Summer Institutes, Magnet and Residential Schools

Northern State College hosts a summer institute. Forty-five students are selected by the directors of the institute on the recommendation of their junior/senior high school instructors. Three-week courses in science, mathematics and computer studies are offered.

Special Populations

There are no special programs for increasing the participation of underrepresented groups in science. If needs are identified by assessment, grants can be allocated and used at the local level.

Staff of institutions of higher learning have been talking to junior and senior high school girls about continuing their studies in mathematics. These staff members travel to local districts to make presentations in the student's home setting.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

Higher order thinking skills are addressed only to the extent that the standardized Stanford test addresses them.

Assessment Content

There is presently no direct coordination between assessment content and state curriculum guides/objectives.

Assessment Reporting

Assessment results are reported for the state and for districts. Only state results are made public.

Assessment results are intended to be used by schools to assess strengths and weaknesses of curricular programs, classroom instruction and student performance. Districts are expected to use results to assess curriculum and make changes, and state education policy makers are to use results to assess the state as a whole and to prepare future directions.

Subjects Areas Assessed

Students in grades 4, 8 and 11 are annually assessed in mathematics, reading, social studies, language arts and science.

TEACHERS

Teacher Recruitment and Retention

No recent initiatives have been adopted to attract or retain science and/or mathematics teachers.

Teacher Shortages

Many teachers are teaching science with a minor, and it is considered unlikely that these teachers are fully prepared to teach science. South Dakota has only two teachers who majored in physics. A mathematics teacher shortage is reported, as shown by the first-year teachers who are part of the Associate Instructor Program. (For details of this program, see the "Certification Requirements" next.)

Certification Requirements

The Elementary Certificate Endorsement requires two semester hours of arithmetic for elementary teachers, two semester hours of physical science for elementary teachers and two semester hours of biological science. The Secondary Certificate Endorsement requires a major in an academic or special field approved for endorsement.

Effective July 1, 1987, a teaching assignment outside the teacher's major area of academic preparation requires the following minimum preparation: 12 semester hours of science for a middle school/junior high school science teacher, including biological science, physical science and earth/space science; 18 semester hours for a high school teacher of earth/space science, including at least one course in earth/space science; 18 semester hours for a high school teacher of general science, including at least one course in a biological science and one course in a physical science; 21 semester hours for a high school teacher of a specific science with at least 12 semester hours in each category taught, including, but not limited to, biology, chemistry, physics and physical science.

Teachers must complete six credits every five years (not restricted to major or minor areas) to renew certification. An Associate Instruction Program is in effect in which teachers receive a probationary certificate for the first year of teaching. A team of three people, consisting of the school principal, a representative from higher education and a coordinator from the State Division of Education, reviews the teacher in his or her classroom and makes a recommendation regarding full certification.

Alternative Certification

Emergency certificates may be issued by the State Department of Education to candidates with a bachelor's degree who agree to complete standard certification requirements within two years. During the 1986-87 school year, 17 people in mathematics received emergency certificates, and approximately 10 to 15 people per year receive such certificates to teach science.

Teacher Training

Through Title II funds various programs are being undertaken to upgrade teaching skills in science and mathematics.

Staff Development Needs

Elementary teachers need more science background and information on methods of teaching science. Many physics teachers need more courses in content and methodologies. The greatest staff development need for mathematics teachers in grades K-6 is how effectively to use manipulatives in instruction. In grades 7-12 teachers' needs include teaching higher order problem solving skills, visualization in all areas of mathematics, and how to integrate the calculator and computer in instruction.

FUNDING

Title II funds are principally used to develop local school inservices in science and mathematics including integration of computers. Districts often pool their funds to bring in speakers who provide inservice programs. A few districts sent teachers to summer workshops sponsored by in-state and out-of-state institutions of higher education. No additional state monies targeting science or mathematics instruction were reported.

RECENT STATE REFORMS/NEW INITIATIVES

No recent state reforms that have affected science or mathematics instruction were reported.

TRENDS AND ISSUES

The three biggest problems South Dakota faces in improving science instruction are:

1. Elementary teachers need more content and methodologies;
2. Physics teachers need more content and methodology; and
3. Schools, especially elementary schools, need more equipment and materials.

The three biggest problems in improving mathematics instruction are:

1. The public needs to be educated about what mathematics is;
2. College and university instructors need to be updated; and
3. Teachers need time to plan activity-based learning.

TENNESSEE

CURRICULUM

Curriculum Guides

Tennessee's science curriculum guide, developed by a task force of classroom teachers, college instructors and the state science curriculum consultants, contains the broad goals and objectives of the science curriculum framework. It also contains suggested content, skills to be developed and activities appropriate to the objectives. Districts are required to implement the state-developed curriculum frameworks. The guides were last revised in 1987 for grades K-12.

The state has a set of required State Mathematic Frameworks which are broad outlines that include goals and terminal objectives. The state also has a set of required guides that extend the frameworks by adding instructional objectives, content, necessary thinking skills and activities. Both the frameworks and the guides were developed by Tennessee's mathematics consultant, Karen Hanna, and state teachers. Revisions for grades K-8 were last made in 1986; revisions for grades 9-12 were made in 1987.

Higher Order Thinking Skills

Necessary higher order thinking skills are listed beside each activity for every instructional (behavioral) objective in the guides K-12. Teachers of grades 9-12 are required to comply with state legislation that calls for teaching reading, writing, speaking and listening, mathematics, reasoning and study skills in the science classroom. The integration of these components require higher order thinking skills.

Time Requirements

Although there are no specific time requirements for science in grades K-8, the curriculum framework requires that sufficient time be devoted to fulfill its stated objectives. Students in grades 9-12 must complete two units of science for graduation.

The state recommends that students in grades 1-3 receive a minimum of four hours per week of mathematics instruction and that students in grades 4-8 receive five hours per week of mathematics instruction. Students in grades 9-12 must complete two units of mathematics for graduation.

Graduation Requirements

Effective with the class of 1988, students must complete two credits of science and two credits of mathematics to graduate from high school. Students must also pass a proficiency test in mathematics to graduate. The test is first administered in the 9th grade. Students may retake the test once each year and twice in their senior year if necessary. If students fail to pass the test after five attempts, they are awarded a "Certificate of Attendance" in place of a diploma. Tennessee also offers an Honors Diploma that, among other things, requires three units of mathematics.

STUDENTS

Recognition and Awards

The state of Tennessee sponsors an Honors Program to recognize outstanding students in academic areas, including science and mathematics.

Summer Institutes, Magnet and Residential Schools

The Martin Luther King High School and the Memphis East High School, both located in Nashville, are special schools for students interested in studying science and mathematics. Students must apply to the schools and are selected on the basis of aptitude, scholastic ability and interest. Approximately 1,500 students participate each school year. Both schools are funded as regular schools.

The state also supports a four-week summer institute for students interested in science and mathematics. Students must apply and submit a project. The approximate 100 yearly participants had to apply and submit a project. Participants then work individually on special projects.

Special Populations

COMETS (Career Oriented Modules to Explore Topics in Science) is a state-initiated program designed to increase the participation of underrepresented groups in science education. Members of industry contribute by providing teachers with materials to help stimulate participation of these students. Project EQUALS promotes the participation of students and adults in mathematics courses, fields of study and work. Curriculum materials are provided for teachers, students and parents at the elementary and secondary levels.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

Higher order thinking skills are not assessed in Tennessee.

Assessment Content

The state-constructed tests are developed with the help of educators (classroom teachers, instructional supervisors, etc.) and coordinated with the state's curriculum guides. The tests administered to students in grades 3, 6 and 8 are specifically designed to measure skills taught by a curriculum required statewide.

The test administered to students in grade 9 is designed to assess mastery of basic language and mathematics skills necessary for success in high school. A passing score on this test is one requirement of a high school diploma.

Assessment Reporting

Assessment results are reported for the state, districts, schools and students. Results for the state and districts are made public.

Schools receive school and individual student test results. The results enable a school to determine strengths and weaknesses of the curriculum and areas of need for individual students. Inservice opportunities can then be provided to teachers to strengthen needed areas.

Districts, or school systems, can compare their assessment results with statewide and national average results. Systems can determine broad areas of strengths and weaknesses within the school system as a whole and determine the direction of future curriculum goals.

The State Board of Education regularly reviews test results. The board's long-range plans for core curriculum requirements and graduation requirements can be influenced by test scores.

Subject Areas Assessed

All students in grades 2, 3, 5, 6, 7, 8, 9 and 12 are tested in mathematics and reading; all students in grades 2, 5, 7, 9 and 12 are tested in language arts, social science and science. This assessment schedule is not expected to change.

TEACHERS

Teacher Recruitment and Retention

Loan scholarships are available to undergraduates and current teachers seeking certification in critical shortage areas, including science and mathematics. Additional requirements for students include a minimum GPA of 3.0 and a minimum ACT score of 19 (a score of at least 21 is preferred).

Teacher Shortages

There is not a shortage of science teachers in the state of Tennessee; however, there is a shortage of mathematics teachers. Loan scholarships and recertification projects, instigated by colleges and universities, are in place to address these shortages.

Certification Requirements

Endorsements for grades K-8 require 18 quarter hours of natural sciences and six quarter hours of mathematics. Endorsements for grades 7-12 require 27 quarter hours of mathematics and 48 quarter hours of science, including biology, physics, chemistry, and earth and space sciences.

Effective September 1, 1988, an endorsement in general science will require a minimum of 36 quarter hours of course work, including biology, chemistry, physics, and earth and space science. An endorsement in biology, chemistry, physics or earth and space science will require 24 quarter hours of course work.

The 7-12 mathematics endorsement will be upgraded as of September 1, 1989. Thirty-six quarter hours will be required, including 12 quarter hours of calculus, three of linear or abstract algebra, three of geometry, three of probabilities or statistics, three of computer use and 12 of mathematics electives.

Under consideration is a requirement for professional education experience beyond the initial four years of undergraduate study.

Alternative Certification

Temporary teaching permits, valid from the date of issuance to June 30 of the following year, are available to qualified people only when there is a shortage of regularly certified teachers. The permit may be renewed if the shortage continues to exist the following year. However, the temporary teaching permit does not lead to full certification.

Teacher Training

The state provides inservice training to teachers if requested by a local education agency.

Staff Development Needs

The greatest staff development need among science teachers is the development of a positive attitude toward teaching science in grades K-8.

The greatest needs among mathematics teachers involve teaching techniques. Teachers need to emphasize manipulatives, applications and mathematics reading, writing and oral communication skills.

FUNDING

Districts use Title II funds in a variety of ways, including staff development activities. Additional state monies support the Center of Excellence for the Enrichment of Science and Mathematics Education at the University of Tennessee.

RECENT STATE REFORMS/NEW INITIATIVES

It is hoped that the new career ladder and associated salary increases will promote mathematics instruction by attracting more talented people to the teaching profession.

TRENDS AND ISSUES

The three biggest problems Tennessee faces in improving science instruction are:

1. Negative teacher attitude toward elementary science;
2. Lack of support for elementary science; and
3. Large class size.

Current attention focuses on the effects of reducing class size and providing support systems for elementary teachers in science through local colleges and universities.

The three biggest problems the state faces in improving mathematics instruction are:

1. Out-of-date mathematics instructional techniques;
2. Weak mathematics background of elementary teachers; and
3. High level of mathematics anxiety of students and elementary teachers.

TEXAS

CURRICULUM

Curriculum Guides

The Texas Essential Elements, a curriculum framework developed in 1983-84 by the state education agency, describes required course content for all grades. The mathematics framework includes philosophies of mathematics, correlation of statewide assessment tests to the Essential Elements, use of calculators and methods of problem solving, etc. A course-by-course, grade-by-grade guide is now being developed. Revisions will be ongoing to keep pace with the state's six-year textbook adoption cycle — each year a textbook proclamation addresses the philosophy of the courses being adopted and the structure of the textbooks and teacher editions. Under development in science are revisions for planning a safe and effective learning environment — a science lab faculty guide and a guide on safety practices in science. A major revision of the science frameworks is anticipated in the 1989-90 school year.

Higher Order Thinking Skills

The Essential Elements in science are process oriented, and an Approved Honors Course must include critical thinking and process skills. The mathematics Essential Elements emphasize problem solving, and the textbook proclamation for mathematics asks for problem solving as the focus of the text and requires situations in which students apply problem-solving skills.

Time Requirements

Students in grades 1-3 must receive 100 minutes per week of science instruction. At least 225 minutes per week are required in grades 4-6; 45 minutes per day in grades 7-8; and 55 minutes per day in grades 9-12.

Students in grades 1-6 must receive 300 minutes per week of mathematics instruction. Time requirements in mathematics for grades 7-8 and 9-12 are the same as those in science.

Graduation Requirements

Through 1987, two units of science and two units of mathematics are required for graduation. Students graduating in 1988 must complete an additional year of mathematics (beginning with Algebra I). Students who complete 22 credits will receive an "advanced notation" on their transcripts if the credits include one year of computer science and three years each of science and mathematics along with other subject credits. Beginning with the class of 1987, students are required to pass a criterion-referenced assessment test designed to measure competencies in mathematics. The test is administered in the 11th grade and may be retaken twice during the senior year. Only students who satisfactorily complete the test are eligible for a diploma. Students who are denied a diploma may continue to take the test and will receive a diploma upon successful completion.

STUDENTS

Recognition and Awards

There are numerous local recognition programs, and the state board is considering establishing such programs on a state level in the future. Texas students participate in programs sponsored by the U.S. Department of Energy, the National Science Foundation and the state of West Virginia. Local colleges and universities also sponsor programs.

Summer Institutes, Magnet and Residential Schools

Some summer programs are available through Title II monies and located at individual universities.

Special Populations

Title II programs designed specifically to address participation of special populations include the TexPrep program in San Antonio that identifies bright minority students in 9th grade and beyond with special science and mathematical abilities. The students work with engineers and scientists in the community. The general focus of the state's Title II programs is to address underrepresented groups, although the "problem is not solved by any means."

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

Some higher order thinking measures are included on the present tests, and the state board has a goal of more emphasis on these skills in the future.

Assessment Content

The state's assessment instrument measures a subset of the mandated Essential Elements.

Assessment Reporting

Assessment results are reported for the state, districts, schools and students. Results for districts and schools are made public.

The assessment results are intended to be used by schools and districts to develop and implement appropriate compensatory programs for students not mastering the minimum skills. The results are intended to be used by state policy makers to evaluate textbook proclamations, funding patterns, teacher education strategies and public school education programs.

Subjects Assessed

Students in grades 1, 3, 5, 7 and 9 are assessed annually in mathematics, reading and writing. Spanish versions of the tests are available to students with limited English proficiency students in grades 1 and 3. By grade 11, students are assessed in mathematics and English/language arts.

TEACHERS

Teacher Recruitment and Retention

Forgivable loans are available through individual institutions of higher education to undergraduates and current teachers who become certified in a critical shortage area.

Teacher Shortages

Teacher shortages are reported in mathematics, physical science and chemistry. The state is addressing these shortages through an alternative certification program (see below); individual teacher institutions are conducting heavy recruiting and informal work with high schools to recruit students; and standards for teacher education are being upgraded (this will initially cause a drop in available teacher recruits but over the long run will increase the number of teachers as the field becomes more professionalized).

Certification Requirements

To be accepted into a teacher certification program, all candidates must pass a state-adopted basic skills test, which includes reading, writing and mathematics. At the end of an approved teacher certification program, each candidate must pass a test of professional knowledge and a content test in each area for which certification is sought. The content area tests cover the knowledge needed to teach the Essential Elements.

Certification to teach at all levels requires three semester hours of mathematics (at the content level of college algebra or above) and three semester hours of natural (laboratory) science. Nine semester hours of electives, which include mathematics and science, must also be taken.

Elementary certification (grades 1-8) does not specify additional hours of science or mathematics, but additional course work must be taken in a combination of subjects to assure the inclusion of the Essential Elements in all subjects taught in the elementary grades. Mathematics, biology and earth science specializations require 12 semester hours of course work in the area to receive elementary (grades 1-6) certification or 18 semester hours of course work in the area to receive elementary (grades 1-8) certification. Life/earth science and physical science (chemistry and physics or physical science) specializations require 24 semester hours with at least 6 semester hours in each area.

Secondary certification to teach mathematics, biology, chemistry, earth science or physics requires 36 semester hours in the subject (with 12 semester hours in a directly supporting field) or 24 semester hours in the certification area. Life/earth science and physical science (chemistry and physics or physical science) certification requires 36 semester hours (with at least 12 semester hours in each area). Two 24 semester-hour certification areas are required. Composite science certification requires 48 semester hours of courses in biology, chemistry, geology and physics or physical science with 24 semester hours in one area and a minimum of six semester hours in each area. Composite science certification allows the teacher to teach all sciences.

To advance on the statewide career ladder, teachers must obtain credit for higher education course work or advanced academic training that is related to the job assignment. Course work or training may relate to the subject taught by the teacher, an

area for which certification is sought, instruction for a particular type of student taught or other specified areas.

Alternative Certification

Districts with a documented or projected need for teachers may develop an alternative certification program for State Board of Education approval. Individuals with relevant degrees who meet grade point average requirements (2.5/4.0) overall and in the area of need may be considered if they pass the state-mandated test of basic skills. During a one-year program, alternative certification interns receive student contact experiences and course work and serve as "teachers of record." Upon successful completion of the internship, receipt of an acceptable appraisal and successful completion of certification testing requirements, the district or other sponsoring organization may recommend the individual for certification.

Teacher Training

To upgrade the skills of science teachers, the state education agency is providing technical assistance and inservice programs and workshops in elementary and secondary sciences and earth and life science. To upgrade skills of mathematics teachers, the state is developing Title II programs such as staff development modules in mathematics that address the Essential Elements and integrate content and methodology.

Staff Development Needs

The greatest staff development needs among science teachers are process and content skills (especially at the elementary level) and inservice programs addressing science safety. The biggest staff development needs among mathematics teachers, based on a formal needs assessment in 1984 are: for elementary teachers training in areas they are least prepared to teach, such as geometry, statistics and problems, error diagnosis; for middle school teachers training in teaching with calculators and computers and teaching statistics and problem solving; for high school teachers training in computers in mathematics, calculators, consumer applications, statistics and problem solving.

FUNDING

Districts are using Title II funds to set up a mathematics education resource center, to purchase manipulative materials and information and to provide extensive staff development in a variety of formats. Districts may use flow-through funds to receive state-developed staff development modules. Districts are also using Title II funds to purchase science equipment and materials and and to design inservice programs.

RECENT STATE REFORMS/NEW INITIATIVES

The state continues to review the Essential Elements and graduation requirements to provide direction for planning programs. "The 'no pass/no play' rule has caused some students to avoid higher level classes, but it is nevertheless an excellent rule" — it is possible that districts can waive the requirement for classes such as trigonometry.

TRENDS AND ISSUES

The three biggest problems Texas faces in improving science instruction are:

1. Lack of content and process skills in elementary science;
2. Overcrowding and lack of science facilities, materials and equipment, especially at the 7th and 8th grade levels; and
3. People going into industry rather than becoming science teachers.

The biggest problems in improving mathematics instruction are:

1. The geography of the state — there are rural districts to which it is difficult to provide information and staff development (the state education agency has tried to use distance technology, but the system is far from efficient);
2. Certification standards and teacher education, especially at the elementary level, need to address more mathematics; and
3. A need for continuity of funding; Title II funds are so erratic that it is difficult to implement any long-range programs.

UTAH

Utah did not provide answers to the specific survey questions related to science or mathematics education. The information included here about science was taken from a March 1986 survey.

CURRICULUM

Curriculum Guides

Utah has a recommended set of standards and objectives for grades K-12. Specific smemster CORE courses are required for grades 7 and 8. A field test to evaluate the current guides occurred in 1986.

Higher Order Thinking Skills

The state's effort to incorporate higher order thinking skills is reflected in the languages used in the core standards and objectives. Action verbs such as "identify, distinguish, compare, describe, infer, apply, create and demonstrate" signify that higher order thinking skills are emphasized.

Time Requirements

The state recommends that 5 to 10% of 5th and 6th grade class time be spent on science instruction. Two hundred and fifty minutes per week are recommended for grades 7-9. However, Utah is not an advocate of strict time requirements. Students have the option of working at an accelerated pace.

Graduation Requirements

Effective in 1987, students must complete two units of science for high school graduation.

STUDENTS

Recognition and Awards

Monies that support a wide variety of recognition programs for gifted and talented students are a line item in Utah's Uniform School Fund.

Summer Institutes, Magnet and Residential Schools

Eighth grade students in Utah participate in summer institutes. About 30 students each year are selected for an eight-week course in chemistry.

Special Populations

The Utah Math/Science Network sponsors a workshop each year with over 1,000 participants. The workshop allows girls (and boys) to interact with women who are successful in mathematics/science careers.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

Higher order thinking skills are currently not included in Utah's assessment battery.

Assessment Content

The NRT represents a reasonably good survey of the state's curriculum objectives. However, the state is currently engaged in a major project to develop end-of-grade and end-of-course CRTs that are specifically matched to state objectives.

Assessment Reporting

Assessment results are reported for the state, schools and students. State results are made public; and school results are available if requested from the local school district.

A school's assessment reports provide an opportunity for schools to compare their performance with the state and the nation. They also allow for identification of program strengths and weaknesses.

Statewide results provide information on student performance in a variety of achievement areas as well as in noncognitive areas. Implications for needed changes in program emphasis are provided for use at the state level.

Subject Areas Assessed

In 1987 and 1989, a sample of students in grades 5 and 11 will be tested in mathematics, reading and language arts.

TEACHERS

Recruitment and Retention

To attract teachers into science, Utah has a Utah Career Scholarship Fund through which 165 scholarships are available to high school graduates to enter teacher training (includes tuition waiver and stipends) and 200 scholarships are available to students already in teacher training (includes tuition waiver plus $3,000).

Teacher Shortages

Information not reported.

Certification Requirements

Utah currently has four types of certification: elementary, secondary, vocational education and administrative. Effective no later than the 1988-89 school year, teachers will not be assigned to teach any required CORE course unless they hold a current Utah teaching certificate, have an undergraduate or graduate major or minor, have completed a state-certified inservice program or have demonstrated competency in the specific subject area.

Alternative Certification

To prevent science teacher shortages, the state offers an "Eminence Certificate." This is available on an annual renewal basis to individuals who have not gone through a bonafide teacher preparation program. Doctors, engineers field scientists, etc., are eligible through application and approval but are restricted to teaching two periods per day.

Teacher Training

The larger districts of the state have inservice coordinators who organize workshops in science and other subject areas. In addition, Weber State College, Utah State University and Brigham Young University have organized science education centers. The training programs offered are determined by an appropriate needs assessment sample of representative elementary and secondary teachers.

In 1985-86, the state legisature appropriated $300,000 for training underprepared teachers. The state education agency sponsors and cosponsors a variety of inservice programs. It works with different universities to provide subject-specific workshops; it works with the Utah Science Teachers Association to provide a semiannual conference focusing on teaching skills; and it holds curriculum development workshops. The state education agency also approves, but does not fund, many district programs that provide teachers with additional college credit. Furthermore, the state education agency indirectly funds a teaching center specific to science, located at Weber State College in Utah.

Staff Development Needs

Information not reported.

FUNDING

Funding has increased substantially to emphasize science and other critical areas of education, such as mathematics, foreign languages and special education. Seventy percent of Title II monies are distributed directly to districts on the basis of student enrollment and fund several of the inservice programs for underprepared science and mathematics teachers. The remaining 30% is divided between needs assessment, administrative costs and exemplary inservice programs for science and mathematics teachers.

RECENT STATE REFORMS/NEW INITIATIVES

Information not reported.

TRENDS AND ISSUES

Information not reported.

VERMONT

CURRICULUM

Curriculum Guides

The Vermont Standards for the Approval of Public Schools, developed by the state education agency, are now in place and required for use by local education agencies. Science frameworks, developed by the state education agency, are also recommended. The science frameworks are available for grades K-3, 4-6, 7-8 and 9-12 and were last revised in 1986. In addition, the state recommends that districts develop mathematics curricula using as a model either the Framework for the Development of a Math Scope and Sequence or the framework developed by the Vermont Council of Teachers of Mathematics, A Framework for Mathematics Curriculum Development in Vermont.

Higher Order Thinking Skills

The Vermont standards for mathematics emphasize that local "mathematics curriculum stresses the use of mathematical skills to solve real-life problems . . . [and] uses concrete and pictorial materials to develop concepts and problem-solving skills."

Time Requirements

No guidelines for the amount of time spent on science education are specified for grades 5 or 6; however, half of each day must be comprised of science, social studies, physical education, art, health and music. Students in grades 7-9 are required, for each year of study, to spend at least 200 minutes per week each on science and mathematics instruction.

Graduation Requirements

Effective for the graduating class of 1989, students must complete two years of science instruction and two years of mathematics instruction as part of a combined minimum of five years of instruction in science and mathematics in grades 9-12.

STUDENTS

Recognition and Awards

Local recognition programs exist, but none were reported at the state level.

Summer Institutes, Magnet and Residential Schools

Vermont's Governor's Institute on Science and Technology located at the University of Vermont, College of Natural Resources, is supported by the state. Approximately 50-60 students, selected at the local level, participate each year. State and federal monies amount to 15% of the funds, with the balance made up of private funds.

Special Populations

No specific programs to increase the participation of underrepresented groups were reported.

STUDENT ASSESSMENT

There is no statewide student assessment program in Vermont.

TEACHERS

Teacher Recruitment and Retention

A Loan Repayment Program is available to current science and mathematics teachers who have outstanding loans guaranteed by the Vermont Student Assistance Corporation.

Teacher Shortages

Sporadic shortages of science teachers are reported; shortages of mathematics teachers exist primarily in rural schools.

Certification Requirements

Eighteen credit hours of science are required for secondary certification. Elementary school certification requires candidates to meet competency requirements in mathematics (equivalent to a year of mathematics) and to take six credit hours in science. There is no special certification for middle school/junior high school. Secondary certification requires completion of competency requirements and a second endorsement is available with an additional 12 semester hours.

Alternative Certification

Individuals may obtain initial certification in a shortage area by evaluation if they have documented teaching experience, competence and qualifications, and demonstrate these skills to a review board. They must then complete a 15-week apprenticeship.

Teacher Training

Teacher institutes, workshops, identification of exemplary programs and support of resource persons are methods used to upgrade the skills of science teachers. To upgrade the skills of mathematics teachers, the state assists with local inservice programs and works with colleges and universities, particularly to plan for use of Title II funds.

Staff Development Needs

The greatest staff development need in science among elementary teachers is experience with inquiry- and activity-oriented teaching; among secondary science teachers the greatest needs are low level science and curriculum development.

FUNDING

Title II funds are being used by districts for teacher inservice programs, course work, curriculum development and supporting teacher attendance at science and mathematics institutes.

RECENT STATE REFORMS/NEW INITIATIVES

The increase in the number of years of science and mathematics required for graduation has had a positive effect in both subject areas.

TRENDS AND ISSUES

The biggest problems in improving science instruction are:

1. Shrinking funds for materials and equipment;
2. Lack of the amount of elementary science provided; and
3. Lack of improved science instruction in 7th and 8th grades in small (one- and two-room) schools.

The biggest problems facing Vermont in improving mathematics instruction are:

1. Lack of wider opportunities for low achievers at the secondary level;
2. Lack of increasing the use of manipulatives at all levels; and
3. Lack of emphasis on higher order skills at all levels.

VIRGINIA

CURRICULUM

Curriculum Guides

Since 1983, the Virginia Standards of Learning for Science have been recommended for use by districts. They were developed by the Science Education Service with the aid of field committees. In 1986, minor revisions were made to the standards for grades K-12. The state of Virginia also has a set of objectives related to mathematics that districts are required to include in their local curriculum. These objectives were developed in 1981 by special committees under the direction of the State Department of Education. They are being revised in 1987 for grades K-7.

Higher Order Thinking Skills

There is an effort in the state of Virginia to include higher order thinking skills in science through involving students in "process." There is also an effort to emphasize higher order thinking skills by assessing the essential components of a support system for quality science education and to change the way science is delivered in the classroom. This system is currently being implemented in six pilot districts.

Higher order thinking skills are also being emphasized as a major objective in all areas of mathematics. Special, regional, inservice workshops have been held on a statewide basis.

Time Requirements

The state of Virginia recommends that students in grades K-3 receive at least 100 minutes of science instruction per week. It is recommended that students in grades 4-6 receive at least 150 minutes of science instruction per week; 250 minutes per week are recommended for grades 7-8; and at least two years of science are recommended for grades 9-12.

There are no recommendations on the quantity of mathematics instruction at the elementary, middle/junior high school or high school levels.

Graduation Requirements

Effective with the class of 1989, the Virginia State Board of Education requires two units of laboratory science and two units of mathematics plus one additional unit of science or mathematics for graduation. A competency test in mathematics is also required for graduation. A certificate is offered to students who complete the board-prescribed course of study but have not passed the competency test. Such students are encouraged to retake and pass the minimum competency test to receive a diploma.

STUDENTS

Recognition and Awards

The state supports a Governor's School for Gifted Students in science and mathematics in grades 9-12. A committee selects students to participate in this program on the basis of

test scores. The Virginia Academy of Sciences sponsors the Virginia Junior Academy of Science competition in which junior high school and high school students are eligible to participate. Written science research papers are the basis for selection.

Summer Institutes, Magnet and Residential Schools

Both state and local monies support five magnet schools in science. The New Horizon Magnet School for Science and Technology is located in Newport News; the Roanoke Governor's Science School for Science and Mathematics is located in Roanoke; the Thomas Jefferson High School for Science and Technology is located in Fairfax; the Central Virginia Governor's School for Science and Technology is located in Linchburg; and the Summer Governor's Magnet Schools for Science and Technology (there are six of these schools) are located in southwest Virginia. Three thousand students in grades 9-12 are selected yearly to participate on the basis of test scores, interest in science, high aptitude in science and teacher recommendations.

There are no state-supported summer institutes for students studying science or mathematics.

Special Populations

The emphasis in Virginia is less on special populations and more on students as a whole and making the entire science and mathematics program appropriate for a broad range of students. However, the state is increasing its focus on gifted students as well as on special education students.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

The state's assessment program does not address higher order thinking skills at this time.

Assessment Content

Assessment instruments have been selected on the basis of their correlation with state objectives.

Assessment Reporting

The state reports assessment results for students, schools and districts. District results are made public, and some school districts make school results public.

The state uses a criterion-referenced assessment that supports teachers' periodic assessment of students' progress on adopted learner objectives by assuring that they have assessment resource materials available. The state assessment provides information regarding the educational progress of groups of students in order to evaluate the effectiveness of instruction, redirect instructional activities when needed and to monitor student achievement. Two secondary purposes are to provide information regarding the educational progress of individual students in order to plan appropriate educational experiences for each student and to facilitate school divisions' testing of home-instructed students as required by Section 22.1-254.1 of the Virginia Code. The Minimum Competency Test is designed to ensure that each student demonstrates at least minimum-level competence in reading and mathematics prior to receiving a high school

diploma and to provide information for remediation for those students not demonstrating competence. This program is offered to private schools electing to participate, as well as to all public schools.

Subject Areas Assessed

In 1987, every student in grades 4, 8 and 11 will be tested in reading, language arts, mathematics, social studies, science and reference materials. The state developed a new testing program that recently received board approval. All students in grades 1, 4 and 8 will be tested in reading, language arts and mathematics annually. Beginning in 1990-91, all students who are in the last grade of their school will also be tested (except 12th grade). The last-grade testing is being added to provide information for the identification of commendable and deficient schools.

TEACHERS

Teacher Recruitment and Retention

Scholarship loans are available to college juniors and seniors who are majoring in science or mathematics. In 1985-86, 137 scholarship loans, totaling $274,000, were awarded.

Teacher Shortages

The state of Virginia has a teacher shortage in the area of science, especially earth science. This shortage is being addressed through recruitment efforts by institutions of higher education and through the use of Title II funds. In addition, the state developed a series of 48 television programs to help individuals become certified. Universities and colleges use the videos, but a professor must simultaneously work with teacher candidates for them to receive full certification.

Even though some districts express some difficulty in recruiting mathematics teachers, there is not an official shortage of mathematics teachers.

Certification Requirements

All certificates require a total of 48 semester hours of general education, including at least one course in both natural sciences and mathematics. The Early Education Certificate Endorsement (NK-4) requires an additional 60 semester hours in specialized education, including science and mathematics and electives chosen from science and mathematics. The Middle Education Certificate Endorsement (4-8) requires an additional 60 semester hours in specialized courses, including six hours in both science and math plus 15 hours in science or mathematics if those are the chosen areas of concentration. Biology, chemistry, physics, and earth and space science endorsements require 24 semester hours of course work. The biology endorsement also requires preparation in chemistry, physics and mathematics; likewise, the chemistry endorsement requires preparation in biology, physics, and mathematics. A general science endorsement requires 30 semester hours of course work, including six in each of biology, chemistry and physics, and 12 in earth and space sciences. A physics endorsement requires 24 semester hours of course work, including preparation in biology, chemistry and math. The Secondary Education Teaching endorsement in mathematics requires 27 semester hours, including calculus, algebra, geometry, computer science, programming and language. A general mathematics endorsement requires 18 semester hours of course work.

Alternative Certification

Several of Virginia's institutions of higher education have programs that allow people with bachelor's degrees in mathematics, science, foreign language or English to take a condensed teacher education course and become certified. Program requirements include completion of three education courses and an eight- to nine-week student teaching position.

George Mason University has a program specifically for people desiring to make a career change and become certified in physics, chemistry or earth science. The one-semester program includes earning 15 hours of graduate credit in education and an eight-week practicum.

There is no information available on the number of people who have taken advantage of these programs.

Teacher Training

The Department of Education funds special institutes at colleges, universities and some school districts to retrain teachers and upgrade their certificates. Teaching assistance is provided through certain federal programs.

Staff Development Needs

Science teachers in the state of Virginia lack academic experience in earth science and physics and need to upgrade their background. Teachers should perceive science as an experience and teach concepts and processes. They also need to teach science from a more integrated approach.

Mathematics teachers need to be assisted in developing a positive attitude toward teaching; they need to feel important and appreciated. They also need to be given the opportunity to be creative in the classroom.

FUNDING

Most school districts are using Title II funds to offer inservice programs that improve instructional skills and upgrade teachers' backgrounds. The state provides funds to support institutes for retraining science and mathematics teachers. It also offers science/mathematics scholarship loans to college juniors and seniors who plan to go into the teaching profession.

RECENT STATE REFORMS/NEW INITIATIVES

Increasing the amount of units required for high school graduation has promoted science instruction by focusing more attention on science.

There have no new initiatives that have affected mathematics instruction. However, the state is considering adopting a statewide assessment program using the Sims pool of items and methodology. This program would help to identify areas of weakness.

TRENDS AND ISSUES

The three biggest problems the state of Virginia faces in improving science instruction include the delivery of science as fact rather than concept and process, the lack of certified teachers and the lack of instructional materials. The state is trying to solve all of these problems.

The biggest problems the state faces in improving mathematics instruction include improving teacher and parent attitudes towards mathematics and developing a curriculum that reflects current trends in mathematics. There is currently machinery in place to start programs to strengthen the state's problems. Once data is collected from the assessment program, the state will have a wealth of information to aid in this effort.

WASHINGTON

Washington did not provide answers to the specific survey questions related to mathematics.

CURRICULUM

Curriculum Guides

The Washington State Guidelines contain recommended program goals, general objectives, learner outcomes and instructional implications. A statewide writing team of 25 science educators developed the guidelines in 1985, and they were reviewed by a statewide panel of 35 science educators.

Higher Order Thinking Skills

Goal No. 3 of the state guidelines deals specifically with critical thinking skills; objectives, learner outcomes, instructional implications and examples are included. For the past two years, a major statewide conference on thinking skills has occurred that included sessions specifically directed to science.

Time Requirements

The amount of time spent on science instruction is determined at the local level.

Graduation Requirements

Washington students entering 9th grade after July 1985 must earn two units in science; one unit must be in a laboratory science. Two units in mathematics are required for graduation.

STUDENTS

Recognition and Awards

Recognition programs in which Washington students participate include the West Virginia National Youth Science Camp and the National Institute of Health.

Summer Institutes, Magnet and Residential Schools

There are no special schools for students studying science supported by the state. However, some of the state's colleges sponsor one- to four-week summer institutes that focus on interactive science. Approximately 100 students participate each summer.

Special Populations

The state supports several projects for teachers in an effort to increase the participation of special student populations. Such efforts include MESA (Mathematics, Engineering,

Science Achievement) teacher inservice an the University of Washington, NASEA (Native American Science Education Association) grants to teachers to attend regional conferences, and NDN (National Diffusion Network) sponsored two-day conferences highlighting exemplary science and mathematics programs.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

The MAT 6 includes a higher order thinking skill score. The state also considered some concepts of higher order thinking skills in the analysis of its direct writing assessment in the spring of 1987.

Assessment Content

State level curriculum committees are making recommendations concerning the choice of the commercial standardized tests Washington should use in its assessment program.

Assessment Reporting

Assessment results are reported for the state, districts, schools and students. Results for the state and districts are made public.

State assessment results are used by schools for evaluation and needs assessment of special programs and to plan, in collaboration with students and parents, appropriate educational programs for students.

Districts use assessment results for program and curriculum review, materials selection and public reporting/accountability.

State education policy makers use assessment results for determining resource needs, determining staff/program development priorities, public reporting/accountability and identification of special groups with special needs.

Subject Areas Assessed

Every student in grades 4, 8 and 10 are tested annually in reading, mathematics and language arts. A sample of students in grade 11 was tested in 1987 in writing and language arts. In 1989, a sample of students in grade 11 will also be tested; but the assessment content has not yet been determined.

TEACHERS

Teacher Recruitment and Retention

Undergraduates majoring in science or mathematics may receive a loan for up to $10,000 to complete their studies in teacher education. Ten percent of the loan is forgiven for each year taught.

Teacher Shortages

Washington has a shortage of science teachers. Through the use of Title II funds, districts provide opportunities for teachers to be retrained who are currently teaching science but do not have the equivalent of a minor in science(s). The following numbers of science teachers, to date, have received some type of inservice training: elementary, 1,293; middle school, 264; and high school 290.

Certification Requirements

Currently, only kindergarten through 8th grade or 7th grade through 12th grade certificates are available in Washington. As of August 31, 1987, the following certificates will be available: preschool through 3rd grade, kindergarten through 8th grade, 4th grade through 12th grade and kindergarten through 12th grade. There are no state requirements regarding the amount of training teachers must have in science; each institution of higher education develops their own set of teacher preparation requirements. For elementary certification (K-8), most colleges require at least one class in science methodology. A typical secondary (7-12) certification program might include 45 quarter hours in science. A previously certificated teacher may add an endorsement in another science area with 24 quarter hours.

A year of continuing study consisting of 45 quarter hours of upper division or graduate credit is required in order to receive a continuing certificate.

Alternative Certification

The state does not support an alternate route to certification for science teachers.

Teacher Training

The state education agency offers the following programs to upgrade the skills of science teachers:

- Chautauqua - a program to retrain science teachers
- WAETAG - focus on a science pre-session at the conference for teachers of gifted students
- Vocational - provides monies to upgrade science/mathematics skills of vocational teachers
- NDN Conference - highlight 21 exemplary science/mathematics programs
- Science/Mahtematics/Computer Grants - (state monies available to districts)
- Administering the Title II monies available and providing technical assistance to districts.

Staff Development Needs

The greatest staff development needs among science teachers include adequate content background, particularly at the middle school/junior high and elementary levels and the ability to implement computers in the science curriculum.

FUNDING

Many districts pool their Title II funds by forming cooperatives and offer courses or inservice programs which lead to teaching endorsements. Title II funds also help pay for teachers' registration fees, tuition, etc., for conferences and courses.

RECENT STATE REFORMS/NEW INITIATIVES

There have been no recent state reforms that have affected science instruction in Washington.

TRENDS AND ISSUES

The three biggest problems the state of Washington faces in improving science instruction are:

1. Unqualified science instructors;
2. Underserved populations; and
3. Limited district and state finances which create problems such as a lack of adequate science laboratories, lack of equipment and supplies, substandard laboratory safety and storage provisions and large class sizes.

WEST VIRGINIA

CURRICULUM

Curriculum Guides

West Virginia has Science Learner Outcomes for grades K-12 that define the tasks a learner should be able to accomplish. The outcomes were developed by writing teams of teachers, curriculum supervisors, higher education faculty and the state science coordinator. They were verified for importance and frequency of use by certified, practicing teachers through a process that included teachers from all regions of the state. Districts must prove that the Science Learner Outcomes are incorporated in their curriculum.

The state also has Mathematics Learner Outcomes for grades K-12 that were developed by mathematics educators and verified, approved and adopted by the State Board of Education. The outcomes have been required for use by districts since 1984 and are due for review in 1989.

Higher Order Thinking Skills

Higher order thinking skills are being addressed in West Virginia in several ways. Problem solving is included in the learner outcomes. Materials have been developed to facilitate the teaching of science using an activity or lab-oriented approach. The State Department of Education sponsored the State Education Conference that focused on critical thinking skills. In addition there is a wide range of staff development programs that address this issue.

Time Requirements

The state recommends that 5-7% of a student's day be spent on science instruction in grades K-4, 11-15% in grades 5-8 and 7-8% in grades 9-12. There is an additional 34% of nonallotted discretionary time daily that can also be devoted to science.

It is recommended that students in grades 1-4 receive 250 minutes of mathematics instruction per week; it is recommended that students in grades 5-8 receive 215 minutes per week. Students in grades 9-12 must complete 230 minutes per week to meet the two-credit mathematics graduation requirement.

Graduation Requirements

Two units of science and two units of mathematics are required for high school graduation in West Virginia.

STUDENTS

Recognition and Awards

The State Science Fair, sponsored by the National Science Service, recognizes outstanding students in grades 9-12. The Field Day Organization sponsors the State Mathematics Field Day to recognize the outstanding academic achievement of students in grades 4-12.

Summer Institutes, Magnet and Residential Schools

Special schools, such as magnet and residential schools, are under consideration. There are no state-supported summer institutes for students interested in science or mathematics.

Special Populations

There are no special programs designed specifically to increase the participation of underrepresented groups in science or mathematics.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

Higher order thinking skills are not specifically addressed in West Virginia's assessment program. However, an abilities test is administered that includes both verbal and nonverbal reasoning.

Assessment Content

The assessment committee selects the assessment instrument that best matches the state's learner outcomes.

Assessment Reporting

Assessment results are reported for the state, districts, schools and students. State and district results are made public. Districts may make school assessment results public but the state education agency does not.

Assessment results are used by schools for instructional improvement, career guidance, and educational planning for students. Districts use assessment results for instructional improvement purposes. The results are used by state education policy makers for instructional improvement and accountability.

Subject Areas Assessed

Every student in grades 3, 6, 9 and 11 is tested in mathematics, reading, language arts, science, social studies and reference skills. Students in grades 8 and 10 are tested in writing. This assessment program is not scheduled for revision in the near future.

TEACHERS

Teacher Recruitment and Retention

The West Virginia Scholarship Fund for Teacher Trainees is designed to attract people into the teaching profession.

Teacher Shortages

There are some teacher shortages in the areas of chemistry and physics, and there is not currently a mechanism in place to deal with this problem. Teacher shortages in mathematics are minimal.

Certification Requirements

Individuals desiring to teach early childhood (K-4), middle childhood (5-8) or adolescent education (9-12) are required to pass a test of basic skills prior to admission into a teacher training program. Preparation standards are determined by the institutions of higher education. An exit exam must be passed prior to certification.

Alternative Certification

A public school/higher education partnership that provides training to fully certified teachers assigned to teach in critical shortage areas has recently been approved by the State Board of Education. Participating teachers must complete a summer training session and a one-year internship and are provided with individualized support programs after their competencies have been reviewed and their weaknesses determined.

Teacher Training

Regional staff development workshops provide teachers with science content and methods of science instruction. To upgrade the skills of mathematics teachers, the state education agency has developed instructional materials has identified resources and sponsors staff development programs, including "Train the Trainer" programs.

Staff Development Needs

Science teachers need more opportunities to develop laboratory activities that relate directly to the materials being taught. Mathematics teachers need to identify their personal teaching needs. They also need to be provided with remedial programs and methods of teaching applications to non-college-bound students.

FUNDING

Districts are using Title II funds to identify and address instructional needs using consultants and/or local study groups. These funds are also used to provide teachers with graduate course work.

RECENT STATE REFORMS/NEW INITIATIVES

There have been no recent reforms that have had an impact on science or mathematics instruction.

TRENDS AND ISSUES

The following three issues have been identified as the main problems that West Virginia faces in improving science instruction:

1. Elementary teachers view reading science textbooks as equal to participating in laboratory activities;
2. Secondary teachers often view lecturing and testing for recall knowledge of content as the most important aspect of learning science; and
3. Teachers must give up their evenings and Saturdays to attend professional development workshops and often choose not to do so.

The state is faced with three main questions in its effort to improve mathematics instruction:

1. How do you train elementary teachers to use multiple techniques/algorithms in addressing needs?
2. How do you raise the expectation level of teachers?
3. With given learner outcomes, how do you remediate at all levels to address individual needs?

Progress is being made in all of these areas. There has also been an emphasis on using technology to assist and motivate both teachers and students.

WISCONSIN

CURRICULUM

Curriculum Guides

Wisconsin's Guide to Curriculum Planning in Science, and Guide to Curriculum Planning in Mathematics were developed by statewide committees and the state education agency for all grades. Their use by districts is recommended. There are no required courses, only required topics and a required number of courses. Equivalencies are allowed only as exceptions for individual students and are generally based on schedule conflicts or other difficulties.

Higher Order Thinking Skills

In addition to the recommendations regarding higher order thinking skills in the guidelines, districts are encouraged to use Title II money to develop teachers' skills in teaching problem solving. The state education agency and the Wisconsin Mathematics Council are cooperating to provide opportunities for this development. The state education agency has identified processes associated with each category in the science frameworks, and recommends, for example, that 60% of science time in grades K-2 be devoted to problem solving, 50% in grades 3-6, 35% in grades 7-9 and 20% in grades 10-12.

Time Requirements

Wisconsin recommends that not less than 250 minutes per week at all grade levels be spent on mathematics instruction. The recommendations for science, which are generally adhered to, are 10% of time in kindergarten, 100 minutes per week in grades 1-2, 150 minutes per week in grades 3-4, 175 minutes per week in grade 5, 250 minutes in grade 6 and one full period per day in grades 7-12.

Graduation Requirements

Effective in September 1988 for grades 9-12, two credits of science are required including biological and physical science; two credits of mathematics are required, including arithmetic processes, symbols and properties and elements of algebra, geometry and statistics. This does not exclude courses in general or integrated sciences, or earth science. There is a provision for equivalencies. If it can be shown that an elective course(s) contains approximately the same objectives and time requirements of a required course, the elective course may be considered equivalent. A credit earned via an equivalent course is noted on the student's record. As of July 1985 school boards were given the option of participating in the minimum competency testing program. Mathematic skills are evaluated in these competency tests. Remedial programs are available to students who fail the test. Successful completion of the test can be used as a prerequisite to graduation, although few districts exercise this option.

Districts must enable all students to take science and mathematics every year.

STUDENTS

Recognition and Awards

Mathematics competitions include a mathematics talent search with a recognition day sponsored by the University of Wisconsin, Madison; a team competition with awards sponsored by the Wisconsin Mathematics Council; and other programs, such as Math Counts. Science recognition programs include the National Science Olympiad for middle/junior high school and senior high school students; the Science Congress, a research-based competition for seniors sponsored by the Wisconsin Society of Science Teachers and the Wisconsin Academy of Sciences, Arts and Letters; a Junior Science, Humanities and Engineering Symposium for seniors; and a statewide science fair for seniors sponsored by Marquette University.

Summer Institutes, Magnet and Residential Schools

The state supports a summer institute program for 8th grade graduates entitled Science World. This program is a one-week, integrated physical science/biology/earth science program at Pigeon Lake, Wisconsin in which 360 students participate each year (60 per week for six weeks). It also provides one week of professional development experiences for 120 science teachers each year.

Special Populations

The Science World Program, described above, gives priority to minority and handicapped children who qualify, and 50% of the participants are girls.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

Higher order thinking skills are addressed only to the extent that the Comprehensive Test of Basic Skills addresses them.

Assessment Content

There is no linkage or coordination between the state's curriculum guides and the CTBS assessment instrument used by the state of Wisconsin.

Assessment Reporting

Assessment results are reported for the state and students. The state results are made public. Results are not intended for use by schools or districts, and the assessment results are returned to the students.

Results of the assessment are intended only to provide state education policy makers with a basis for national comparison.

Subjects Assessed

Students in grades 4, 8 and 11 are assessed annually in mathematics, reading and language arts.

TEACHERS

Teacher Recruitment and Retention

No recent recruitment efforts were reported.

Teacher Shortages

In 1986-87 there were 61 emergency licenses issued in science and 39 emergency licenses issued in mathematics. However, the level of competency is less than it formerly was, because many junior high school teachers do not now have secondary mathematics certification. Many are certified to teach grades 1-8, and while they have a proper license for these grades, they know less mathematics than a math-certified teacher at the secondary level would know. The decline in elementary enrollments created a surplus of teachers; at the same time, that a shortage of certified high school teachers developed. The math-certified junior high school teachers were moved to the senior high level, and the surplus elementary teachers were assigned to junior high school. Likewise in science, there are no open positions, but the quality of teaching has declined due to transferring positions.

Certification Requirements

Completion of an approved program is required for elementary certification (study of mathematics and a minimum of 6-15 science credits are generally required). Although there is not a special junior high school certification available, an elementary science minor, for example, would require 28 credits and would allow the candidate to teach general science at the junior high school level; a major in one science and minor in another would be acceptable to teach general science in 9th grade. Broad field science certification requires 56 credits of science and allows an individual to teach science in grades 7-12 but not specific courses in biology, chemistry, physics or earth science in grades 10-12. Teaching those courses requires the appropriate 22 credit minor along with the broad field or another 34 credit science major.

There is not a state requirement for a fifth year of professional education experience, but all teachers must complete six credits of course work (or the equivalent) every five years to renew certification.

Alternative Certification

There is an internship program through which candidates can complete the necessary education courses during the internship if they already have a major or minor (or enough credits) in a subject.

Teacher Training

To upgrade the skills of science teachers, the state conducts a leadership training program which is tied to the Science World program described above. Last year the focus was on elementary school teachers, and the focus will be on teachers at other grade levels in the future. In addition, the Science Education Service Center's project, funded through the National Science Foundation (NSF) provides staff development services to teachers. The project features cooperation between the University of Wisconsin and the state education agency. After the three-year NSF funding expires, the

state will pick up the cost. The skills of middle level mathematics teachers would be upgraded if a proposed certification plan is approved.

Staff Development Needs

The greatest staff development need among science teachers is training and experience in curriculum development and implementation. Among elementary school teachers, a greater understanding of mathematics concepts is needed; among secondary school teachers, greater knowledge of research on teaching and learning in mathematics is a staff development priority.

FUNDING

Districts are using Title II funds to replicate the kinds of inservice offerings typically provided by the state education agency. Some send teachers to meetings and conferences sponsored by the National Council of Teachers of Mathematics (NCTM), the Wisconsin Mathematics Council or the state education agency. The most common uses of Title II funds in science are engaging professors and experts to work with elementary and secondary school teachers via competitive grants, through institutes and workshops. Some have developed consortium efforts through cooperative educational service agencies.

Discretionary funds are available through the state superintendent to be used for leadership training.

RECENT STATE REFORMS/NEW INITIATIVES

New state standards require written K-12 sequential curricula in all subject areas as well as regular instruction at all grade levels. Use of the new curriculum guides to meet these requirements will tend to promote science and mathematics instruction in Wisconsin.

TRENDS AND ISSUES

The three biggest problems Wisconsin faces in improving science instruction are:

1. Finding partnerships with business/industry and schools;
2. Developing local curricula; and
3. Lack of on-going professional development opportunities for teachers.

The biggest problem in improving mathematics instruction is the perpetuation of the past (both in curriculum and instruction) which can be seen through:

1. Too much emphasis on symbol manipulation at all levels;
2. Too much emphasis on demonstration/practice rather than concept development; and
3. In high schools, the systematic exclusion of students of average ability (and below) due to the undue emphasis on the calculus preparatory sequence.

WYOMING

CURRICULUM

Curriculum Guides

Wyoming does not have state mandated or recommended curriculum guideliness for science or mathematics.

Higher Order Thinking Skills

Higher order thinking skills are being emphasized through statewide workshops for teachers at universities and at other conferences. In addition, Title II funds are promoting the emphasis of higher order thinking skills in science and mathematics programs.

Time Requirements

There are no state guidelines regarding the quantity of science or mathematics instruction students receive at the elementary, middle/junior high school or high school levels. However, all state high schools must offer a minimum of one Carnegie unit of science and mathematics per year to all students.

Graduation Requirements

Wyoming minimum standards for graduation, as specified by the State Board of Education, include successfully completing a program of study as identified by the Wyoming School Accreditation Standards. Students must also demonstrate the ability to compute proficiently. All districts must offer a different course selection each year so that a student has the opportunity to take four years of one subject. Regulations require all schools to identify students needing assistance in the basic skills, and remedial programs may be substituted to meet the needs of the individual student. Each school district is responsible for ensuring that the schools under its jurisdiction adhere to the minimum standards.

STUDENTS

Recognition and Awards

Recognition programs for outstanding performance in science in which Wyoming students participate include: the State Science Fair, sponsored by the Wyoming Science Teachers Association (K-12); the Wyoming/Colorado Junior Science and Humanities Symposium (11-12); the West Virginia Youth Science Camp, sponsored by the Governor of West Virginia (two high school seniors from each state participate); and the Science Olympiad (7-12).

Recognition programs for outstanding performance in mathematics in which Wyoming students participate include: the State Math Contest, sponsored by the Wyoming Council of Teachers of Mathematics (7-12); Math Counts, sponsored by the Wyoming Society of Professional Engineers (5-9); the Math Olympiad, sponsored by individual schools (7-12); and a special section for mathematics students in the Science Fair.

Summer Institutes, Magnet and Residential Schools

The state does not support special schools or summer institutes for students studying science or mathematics.

Special Populations

There has been an effort in the state of Wyoming to recruit women and minorities into nontraditional fields such as science and mathematics. Workshops are held for teachers to help them increase the awareness of this need. The state legislature allots money annually for the education of gifted students.

STUDENT ASSESSMENT

Assessing Higher Order Thinking Skills

Wyoming uses the National Assessment of Educational Progress assessment instrument that includes higher order thinking skill items.

Assessment Content

Because the state does not have curriculum guides or objectives, assessment content cannot be coordinated in this way.

Assessment Reporting

Only state assessment results are reported and made public.

State assessment results are used by state policy makers for policy review and analysis.

Subject Areas Assessed

Concurrent with the National Assessment of Educational Progress assessment program, a sample of students in grades 4, 8 and 12 are tested annually in reading, writing and social studies.

TEACHERS

Teacher Recruitment and Retention

Title II monies may be used to help current teachers become recertified in foreign language, science, mathematics, computer science or telecommunications.

Teacher Shortages

Wyoming does not have a shortage of science or mathematics teachers.

Certification Requirements

No specific amount of science or mathematics training is required for elementary certification. However, a methods course in the appropriate field is part of all undergraduate programs. Secondary certification in science requires a minimum of 30

semester hours, including course work in biological science, earth science, physical science and mathematics. Secondary certification in mathematics requires a minimum of 24 semester hours, including course work in linear algebra and calculus.

Alternative Certification

The state of Wyoming does not support an alternate route to certification for science or mathematics teachers.

Teacher Training

To upgrade the skills of science and mathematics teachers, the state education agency provides professional growth workshops, inservice programs and conventions.

Staff Development Needs

Science teachers need to be provided with opportunities to incorporate fully higher order thinking skills into the science curriculum. Mathematics teachers need to learn alternative strategies for teaching mathematics that are exciting and dynamic.

FUNDING

Districts use Title II funds for teacher inservices and workshops. No other state monies targeted to science or mathematics instruction have been made available to districts.

RECENT STATE REFORMS/NEW INITIATIVES

There has been no recent legislation that has affected science or mathematics instruction.

TRENDS AND ISSUES

The biggest problem the state of Wyoming faces in improving science instruction is getting teachers to understand philosophically the real mission of science instruction, which is teaching science as a creative, inventive endeavor. Some mathematics teachers also need a clearer understanding of the total scope of mathematics education.

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